Forage Crops
and Silage

WORLD CROPS

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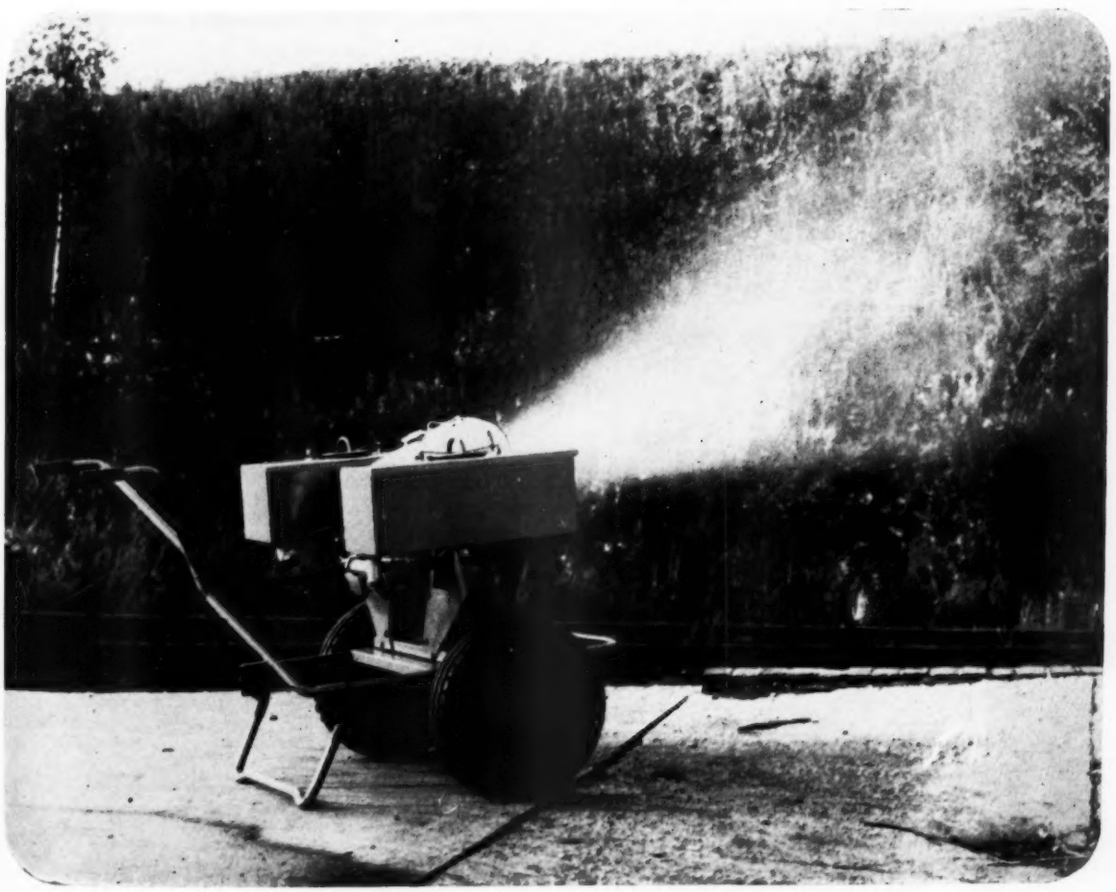

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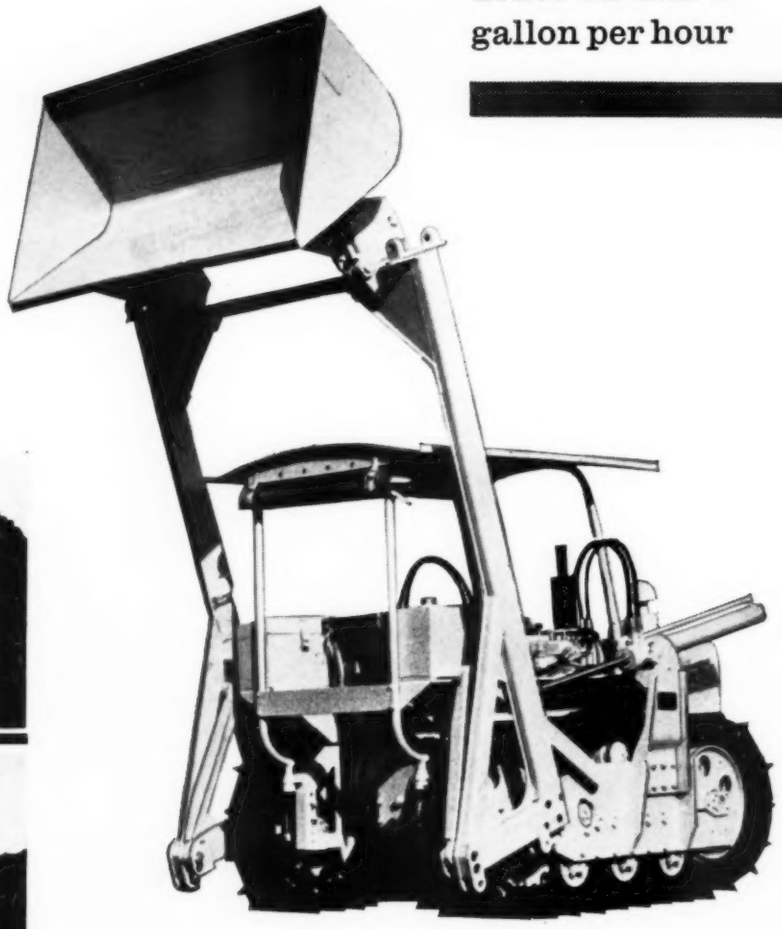

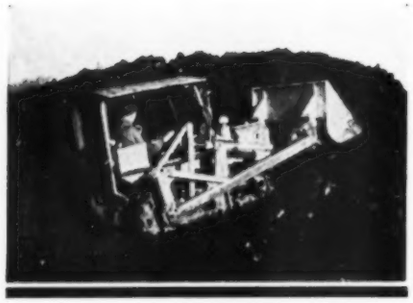

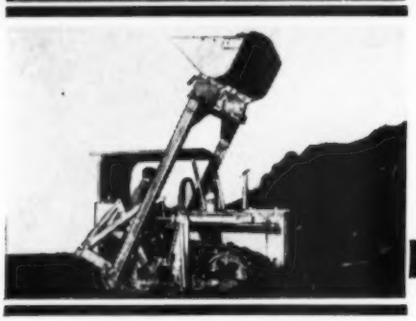

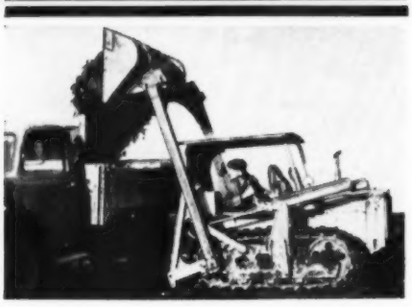

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Editorial Comment

Pasture improvement

WHEN horse-ploughing was the general practice it was always imperative to start ploughing early in order to get it completed before sowing and planting time. Farmers then appeared to be fully appreciative of the advantage of ploughing heavy land early in winter and took every advantage of the tilth-forming action of frost on such land by having it ploughed before heavy frosts were due.

Today a tractor is used and there is no longer the compelling necessity to plough early from the point of view of getting the work completed in time. There is still the same necessity, however, to plough early if advantage is to be taken of the effects of frost in aiding cultivation and so obtaining a good tilth later. No implement or cultivator can be used which will approach in effectiveness the action of rain and frost in producing a good tilth in heavy soils and in making available to the plants the foods present in the soil.

It has been said that the best system of farming to maintain health in livestock is to take the plough round the farm. This acknowledges the fact that ploughing is a refresher of stale land, whether this be through the act of turning over the soil or through the land being free of stock during the time it is being tilled and cropped.

A common practice on many farms is to reserve a grass paddock close to the farm buildings on which the young calves are grazed year after year. Recent investigations have shown that such paddocks are often heavily infested with parasitic worms. Similarly, land on which sheep, poultry and pigs are kept continuously tends to become heavily infested with various parasites. On farms where only a limited area is tilled, this is likely to become a serious problem, unless care is taken to avoid its occurrence. This may be done by ploughing each year the fields which have been in pasture for several years and grazed intensively by stock during that time. In this way the pastures can be freshened in rotation.

Besides keeping the pastures healthy for stock, this practice is also of great value in maintaining them in a state of high productivity. Any fields having a sward of weedy, inferior grasses and a mat of old fog on the surface should be ploughed. This mat prevents air and moisture as well as the fertilisers and lime from reaching the roots of the pasture plants. Such a pasture is largely a waste of land, as it produces comparatively little food.

The condition is due to a combination of factors, including a lack of fertilisers, leading to low soil fertility, inferior or unsuitable seed mixtures and wrong grazing management of the sward. Hence ploughing is only the first step in the improvement programme. It is necessary, in addition, to build up soil fertility, to sow a suitable seeds mixture and to manage the sward properly. This will ensure that the new pasture will not only be productive, but will also be free from parasites which endanger the health of stock.

More winter milk

CABBAGE AND kales are valuable stock foods, and it is surprising that a larger area of them is not grown, especially on dairy farms. The total area under these crops in Northern Ireland in 1956 was 4,470 acres, or one acre of cabbage and kale for 60 cows. In England and Wales last year the ratio was one acre for 14 cows.

Kale responds well to heavy manurial dressings and yields of well over 30 tons per acre can be obtained; at least one and a half times as much produce as turnips. Kales have a higher dry matter content than swedes, contain about twice as much protein and have a slightly higher starch equivalent value. Moreover, they are much richer in vitamin A and contain about twice as much mineral matter as swedes. The mineral content is well balanced, being rich in lime, chlorine, phosphorus and sulphur – with satisfactory amounts of iron and magnesium. A crop of marrow-stem kale of 20 tons will provide as much protein as is contained in nearly one ton of linseed cake, and more than twice as much starch equivalent as is contained in the grain from an acre of an average oat crop. Cabbage, though not as rich as kale, is also a most useful succulent food. There is, it would seem, a sound case for an increase in the area under cabbage and kale even though this would cause a reduction in the area of swedes and turnips.

The value of kale and cabbage in the winter feeding of housed cattle, particularly milking cows, according to the Department of Agriculture of Northern Ireland, can hardly be overstressed. Their use when cows are first housed in the winter enables the change over from pasture to house feeding to be made with the minimum of disturbance to the digestive system of the animals. *Milk yields decline rapidly in late summer and early autumn, unless cows are given fresh succulent food from the time the grass is past its best.* Cows given cabbage or kale will maintain their yields. Should yields be allowed to drop, good feeding later will not restore them to their normal level.

Cabbage and kale can be grown successfully on practically all types of soils if given good dressings of farmyard manure and artificial fertilisers. They are excellent cleaning crops and should normally occupy the same place in the rotation as a crop of potatoes or roots.

Expanding agriculture

AT PRESENT prices it has been estimated that the U.K. could save about £50 million a year on imported cattle feed if its grasslands could be made more productive.

The expanding use of chemical fertilisers was helping to achieve this objective, suggested Sir Alexander Fleck, chairman of Imperial Chemical Industries, when inaugurating the new Leith fertiliser works of I.C.I.'s subsidiary, Scottish Agricultural Industries.

The new works, which had cost £3 million and employed some 220 people, would, he hoped, be regarded as ' harbingers of an expanding industry '.

Scotland is already consuming nearly three times as much fertiliser as before the war and five times as much lime. A further rise in the productivity of Scottish farms by the use of more machinery, biological improvements – better crop varieties and livestock breeds and the expanding consumption of fertilisers and lime – can now be anticipated.

Seafood for cattle

SEAWEED HAS been used from time immemorial both for fodder and fertiliser but it is only in recent years that its valuable nutritive properties have been scientifically established.

Analyses show that seaweed has a composition very different from that of land vegetation. The ash content – with its some 60 micro-minerals and trace elements – is much higher than in land plants, varying between 15% and 25% of the dry matter compared with 5% to 6% in hay, and 4% and under in various grains. The vitamin content is exceptionally good and it is rich in carbohydrates. The calorific value of seaweed is not particularly great, however, and the meal is, therefore, not recommended as a basic fodder, but as an additive to meal for livestock. Generally a supplement of some 2% of seaweed meal is suggested. Remarkable results are claimed due to supplementary feeding with seaweed meal in cases where the previous diet was not scientifically balanced and complete, and these include increased milk yields, improved quality of milk and improved egg laying.

In the course of ages, many valuable elements are taken out of the soil by cultivation. Many more have been washed out of the soil and into the sea, and these are absorbed by the seaweed. The exhaustion of the soil has become evident in a number of places in the form of deficiency diseases. For example, struma, resulting from iodine shortage, is a widespread phenomenon in inland districts. Seaweed meal is an excellent and cheap corrective. The question of using seaweed in fodder is in general an economic question.

Norway has Europe's biggest seaweed resources and the process used in producing the meal involves natural drying of the seaweed in the sun, a coarse preliminary shredding at the processing plant, an artificial drying, cleaning, desalting, sterilising in rotating drums and a final grinding to various degrees of fineness to suit various animals.

Although essential trace elements, as and when they are discovered, are today added to concentrates, they have not yet all been identified but it is safe to assume that all the essential elements will be present in seaweed.

Why make silage?

GOOD GRASS is, of course, the cheapest and most satisfactory food for cattle, if only it were available all the year round. Although the length of the free-grazing season can be greatly extended by the use of certain strains of pasture grasses and legumes, and by careful management of the pastures, the growth of grass, for all intents and purposes, ceases when the temperature falls below 40°F. What is required therefore is a cheap winter keep and the answer is ' silage '.

Good silage provides feed of equivalent value at a little more than twice the cost of grazing, whereas purchased feeds cost five times more than grazing. According to Leaflet No. 101 of the Ministry of Agriculture of Northern Ireland, good quality grass silage is capable of maintaining the production of at least 2 gal. of milk per cow per day and of producing liveweight gains in fattening cattle of up to 2 lb. per head daily. On the other hand, it is stated that hay of the quality usually produced, will scarcely provide for the animals' maintenance requirements.

At one time the making of silage was a laborious and time-consuming proceeding, but again the agricultural engineer has come to the rescue and provided labour-saving machines and special equipment, which makes it possible to cut the herbage or other materials at exactly the right time to give the most nutritious and attractive feed for the cattle. The recent development of the system for self-feeding also obviates the need for cutting and transporting the material from the silo.

Another view

ACCORDING TO Mr. W. G. Barber, President of the Compound Animal Feeding Stuffs Manufacturers' Association, ' the case for grass is being blatantly overstated. The suggestion has been made that the proper use of our grasslands would enable our cattle population to be fed virtually without the help of any imported feeding stuffs '.

Obviously, stock must be fed properly balanced rations if they are to achieve the best economic output. On some farms it is possible to achieve this largely from the production of the farm itself, but on many – and particularly the small acreage farms – this can only be done by buying in concentrates to make up for the lack of acres. If it is considered desirable in the national interest to lower the imported feeding stuffs bill, then a greater production of barley, largely

th rough increased yields, is the surest way to achieve that end.

It is our view that it is essential that European countries should increase the productivity of their grasslands and for that matter of barley and other fodder crops, because the countries which produce the oilseeds, such as copra, palm kernels, etc., may not be prepared much longer to allow the cake to be exported, as this represents a constant drain on the fertility of the soil. It could be better used in those countries to provide much needed feed for cattle, livestock and pigs, thereby replacing through these animals the loss in plant nutrients.

The destroying goat

THE DEPARTMENT OF AGRICULTURE in Cyprus has for some years been carrying out research into strains of pasture plants, methods of reseeding and soil amelioration, conservation practices and management and after assessing all the information collected, it was decided to inaugurate a £100,000 Pasture Improvement Scheme.

Basic information on the type and extent of existing land available was still required, and so it was decided to have a survey made of all the uncultivated land outside the main state forests. This was carried out by Hunting Technical Services Ltd. and has taken 18 months to complete. The pastures were divided into three categories for mapping: (1) land on any geological substratum suitable for pasture establishment without extensive preliminary treatment; (2) land on any geological substratum suitable for pasture establishment with preliminary deep cultivation or clearing and/or soil cultivation measures; (3) land sometimes suitable for reseeding, but only after special treatment, divided into 16 types, mainly on a geology and soil basis.

In Cyprus, as in most of the Mediterranean countries, the uncontrolled grazing of farm animals, especially goats, has been very destructive and the effects of the long-continued misuse of land can be seen in the general degradation of the vegetable cover, in the erosion of the soil and in the lack of soil moisture, because the soils are deficient in humus.

'Consols of the East'

THE COCONUT palm has been variously described as the 'Tree of Life', the 'Tree of Abundance' and the 'Tree of Plenty', because the sap, the leaves, the fruits, the trunk and the roots of this remarkable tree yield well over a hundred products of domestic, industril and commercial value. Well may it be described as the most useful tree in the world.

The vast coconut industry has indeed wide ramifications. It is not just a matter of planting, cultivating and harvesting the crop merely as a food; it also provides employment for a large army of workers for the production of copra – the commercial product which is exported – and the shells are used as fuel in the manufacture of lime, bricks and tiles. Other dependant industries are coconut oil extraction and coir fibre milling; desiccated coconut production, margarine manufacture, glycerine, and soap making; rope-winding, mat and net weaving; broom and basket making; the production of furniture and upholstery; house and bridge building; the manufacture of pharmaceutical and toilet preparations; the production of toddy (similar to ginger beer), the distillation of arrack (a spirit) and the production of gin, liqueurs and medicated wines.

In spite of the invention of the synthetic detergents, which have provided a substitute for the washing soaps, and have thus reduced the amount of coconut oil used in their manufacture, coconuts are still a sound long-term investment and, as such, may still be described as 'The Consols of the East'. In actual fact, but for this scientific revolution, there would have been an acute shortage – indeed a world famine in oils and fats. World population continues to increase at a terrifying rate and, in spite of the temporary glut of butter and margarine in Europe and America, it cannot be said that the world, as a whole, is over-supplied with oils and fats – on the contrary. *The vast majority of the ever-increasing world population is undernourished.*

So far as coconuts are concerned, the position is much more serious than may be realised, because the majority of the palms have passed their allotted span of 'three score years and ten', are now a declining asset and are in need of early replacement. The coconut industry which is today about 15 million acres in extent has reached its dotage and is in urgent need of rehabilitation, its establishment having been the direct outcome of the birth of the soap and margarine industries in Europe in the second half of the 19th century. For the most part, however, the industry is in no position to provide the capital for what today is a most expensive operation. It may not be generally realised that it is not basically a plantation industry – that less than 10% of the world's coconut growers keep any sort of accounts and less than 5% set aside any capital for depreciation and renewals. The majority of the growers, of necessity, lead a hand-to-mouth existence and their lot has worsened with the increasing fragmentation of their properties with successive inheritance. In some cases, even a single tree is shared.

In India and in Ceylon, where there are other prosperous industries to carry the heavy burden of the cost of rehabilitation – both of the crop and of the soil – replanting has been in progress for the past seven

* Consols: a form of British Government stock which originated in 1751, giving a small fixed rate of interest over a long period of time.

or eight years and is proceeding in an orderly and planned manner, according to a long-term programme. But in the more remote coconut-growing regions little or nothing can be done without outside aid on a massive scale. During successive periods of low prices, these regions have in the past had to go out of production because it did not pay to collect the nuts, as the price paid for copra was then so low, being below the cost of production. This economic disadvantage applies wherever the produce has to be carried long distances by path, road, river and schooner to the ultimate port for overseas shipment. The position has worsened in recent years because the people in these remote places have been encouraged to buy the expensive manufactured products of the industrial countries. It has never been properly appreciated what happens when the principal agricultural product, which in many cases is the only export commodity of any importance, becomes unsaleable.

This is the situation which has to be faced by several of the newly self-governing countries. Some of them are indeed already in the ' red ', not because of bad management, etc., but because the price of imported manufactured goods has tended to increase, while the prices of primary products have tended to fall. If the economic situation deteriorates, from where is the money now needed for the rehabilitation of the world coconut industry to come? It is no use saying that this is not our concern – the weakest must go to the wall; it is very much the concern of every nation in the world that the world's supplies of oils and fats shall not only be maintained but shall be doubled, because that, in fact, is what is happening to the population of the world.

In his Presidential Address to the 1957 Conference of the British Association of Science, Prof. P. M. S. Blackett called for financial aid for under-developed countries to the tune of £1,000 million. As might be expected this message was not well received; he was even criticised for departing from precedent by speaking outside his subject. His message was not understood and was quickly forgotten. But the writing is on the wall – ' we live in one world '.

Lime for lucerne?

A STUDY OF molybdenum deficiency in Cape Province, South Africa, has been reported by the Agricultural Research Station there, which is situated in a high rainfall area particularly suited to the cultivation of lucerne. It has been discovered that the large quantities of lime required for the successful production of this deep-rooting, drought-resisting perennial may be the result of low molybdenum content of the soil. Investigations are being made to determine whether it would be possible for heavy liming to be replaced by additions of molybdenum at a lower cost, since lucerne crop failures have been known to occur in cases where soil *p*H would suggest that liming was unnecessary. The Research Station would welcome any information concerning lucerne or legume cultivation on acid soil.

Self-help for coffee

THE RECENT attacks on Vice-President Nixon in Lima and Caracas and the lack of enthusiasm with which he was received in other South American capitals has drawn attention to the resentment which many of the more articulate Latin Americans feel towards the U.S.A. One of the chief reasons for this attitude is the precarious economic situation in many Latin American countries (though in Venezuela less than most) due to the decline in the world price of crops, and particularly of coffee, which is one of Latin America's staple exports. Since the U.S.A. at present imports the great bulk of Latin America's coffee, the producers are apt to blame the former when the price is low, and to react with some political bitterness.

Colombia, the second largest coffee exporter, began to feel the effects of a drop in prices back in 1955 and, although there have been some fluctuations, her coffee exports, and consequently her trading position, have tended to worsen ever since. Brazil, the largest exporter, has recently experienced similar difficulties and by 1957 other exporters in the area were affected.

Last October, Brazil, Colombia, Mexico and four Central American countries agreed at a meeting in Mexico City to reduce their exports to 80% of those in the two previous years. They trusted that this would halt the fall in prices.

It seems a pity that this remarkable exercise in co-operation between rival producers is directed only to a negative and restrictive end, which sadly recalls the pouring of coffee into the sea which was one of the symptoms of the great slump between the wars. Latin American countries faced with this problem of insufficient markets for their coffee have also frequently tried to ensure markets by a rigid bilateralism: only those countries which undertook to import coffee in large quantities would be enabled to export freely to the coffee-producing country. This has two obvious disadvantages from the Latin American point of view: by limiting the sources from which they obtain supplies, they tend to pay more for them; and since only countries with directed economies can guarantee to import particular amounts of coffee, trading partners may be limited against Latin America's interests. But a much more positive policy is not impossible. Since the Latin American coffee producers have been able to co-operate in restricting their exports, may they not also be able to work together on a more active sales campaign in Western Europe and perhaps also in Commonwealth countries? We would certainly like to see more Latin American coffee drunk, and a fair price paid for it: this may require co-operation in advertising, rather than in restriction.

Forage Crops and Silage

J. N. SHARROCK
(*National Agricultural Advisory Service*)

Apart from its value as a winter feed, the practice of making silage a regular part of farming routine has an importance in grassland management that it is difficult to over-emphasise.

GRASS is the most important forage crop in Britain. On the wetter side of the country, the north and west, grass covers three-quarters of the agricultural land and on the drier and more ploughable side – the south and east – half the farming land is under grass and leys. In a few cases arable green crops, such as oats and tares, or maize, or rape may be grown, specially to supplement a summer shortage of grass, but grass, directly grazed, is generally by far the cheapest food for stock in summer.

Within the limitations of their soil and climatic conditions, therefore, stock farmers are aiming more and more to provide grass keep both earlier and later in the season, and to even out the growth of leafy grazing during the summer months. The sowing of special leys, the manuring and management of these and of the general-purpose leys and also of old grassland all play a part in ensuring long and even grazing.

Winter feed

At the same time, some provision for winter fodder must also be made, and again the biggest contribution must come from the grassland. In the present economic conditions it is important that such fodder should be of high quality and produced in adequate quantity, so that any concentrates that have to be purchased are used only for production, as the maintenance needs of stock cannot, at present prices, be economically provided from the cake bag.

The provision of adequate high-quality winter fodder and of enough leafy summer grazing need not be antagonistic; in fact, they are complementary operations. The practices of extensive grazing and haymaking, as the only methods of using grass, however, may have been satisfactory when concentrates were cheap, but with dear concentrates greater control of the grass than these methods can give is needed and some silage making is generally the answer.

Grass that is under-manured and allowed to run to head starts growth late and gives poor aftermaths, whereas grass that is made up of the right strains and adequately manured will give leafy growth in the off seasons when it is grazed or mown, at a leafy stage with suitable rest periods. When haymaking is the only means of conservation there are no early aftermaths available; consequently a larger area for grazing than the animals can use before it runs to head has to be allowed, otherwise they may be short of grazing. Also, if hay is the only grass fodder provided for winter use, the large quantity that is needed entails two risks. One is that some hay will be a poor feed, even if well made, because it can not all be cut before the grasses set seed, and the other that the large amount of hay to be made makes it improbable that it can all be got in without serious weathering.

When silage making is introduced into the conservation routine, grass cut for silage in April or May, according to district and season, and manuring, will ensure some strong leafy aftermaths in May and June. These early aftermaths make it possible to use less land for grazing early and the silage reduces the need for hay, so that the area to be set aside for hay early in the year can also be smaller. Such a reduction in the main haymaking area ensures that it can all be cut before the grasses are too old, while the reduction in the quantity of hay needed ensures that it can be made well.

Following May cuts for silage, the early aftermaths allow the land that was grazed early to be rested and with manuring this can provide further crops for silage, or, if it is needed and the weather is right, a later leafy cut of hay. The aftermaths following the first made hay can be grazed or ensiled later in the summer and autumn.

Not only is silage an excellent winter food and a standby against serious drought or other unfavourable weather,

Photo: Shell Co.

Stock self-feeding at the face of a clamp of silage have 9 in. of silage face per head and access 24 hours a day. No other feed is given

Harvesting maize in France with a Silorator forage harvester, powered by a Renault 35 tractor

but silage making helps the farmer to keep his grazing leafy and to make better hay than is the case when the quantity to be handled is excessive. Therefore the practice of making silage a regular part of farming routine has a value in grassland management that it is difficult to over-emphasise.

Grass silage and hay

Up to the beginning of the second world war the small quantity of silage then made in Britain was produced mainly from arable crops, such as oats and tares, grown specially for the purpose on a few farms that had tower silos and cutter blowers. If silage was made from grass, it was generally a salvage operation on material that had been cut for hay and was spoiling. This could not make really good silage and it is small wonder that silage-making from grass was slow in developing. Good grass silage was then scarcely known; the area of productive leys was small; and suitable equipment for silage making from grass was lacking.

At the end of the war the total annual production of silage was less than half a million tons; one-third of this was made from arable crops and two-thirds from grass. Since then silage making has increased and at the present time about three million tons a year are made; practically the whole of the increase has been made from grass, clover, lucerne and similar crops. Though this increase has been considerable, there is scope for a still larger quantity of silage to be made for the economical production of meat and milk.

The annual production of hay in England and Wales is between six and seven million tons. Allowing for the fact that silage contains four or five times as much moisture as hay, this means that something like eight to nine times as much grass is still made into hay as is ensiled. Analyses indicate that a good deal of the hay produced is not of high quality and too much is of low feeding value, some being little better than straw. As explained, turning more grass into silage would improve the chances of making better hay. If more farmers who do not make silage adopted this practice, they would find also that it would give them better control of their grass and would make it worthwhile to manure it. This would result in more grass and more nutritious fodder.

Silage collecting equipment

At one time the lack of silage-making equipment, as well as lack of experience in its manufacture, was a real deterrent to progress. Mechanisation has resulted in systems for making and moving silage to suit different conditions.

The buckrake, for collecting greenstuff from the swath, can be used on reasonably short and straightforward hauls as a one-man outfit on the small farm, or in pairs or in threes for larger units. It can carry its small loads straight on to a pit or clamp silo, and with skilful placing, shaking out of the greenstuff, and even compaction is not difficult. Green-crop loaders which also collect from the cut swath and deliver the green crop to a trailer are less used than they were before buckrakes appeared, but they still have a place on some farms where the haul is long or the road to the silo is not easy for the buckrake to negotiate.

The green-crop loader, with a specially designed hitch and a specially designed small trailer, can be used as a one- or two-man outfit to run straight on to the silo. Ropes under the load and a hitching post can be used to unload the greenstuff at the silo and with experience, using suitably wilted young grass, the small loads which have not been trodden on in loading can be so placed that, again, shaking out and even compaction need not be too difficult. With good organisation and a good crop this outfit and two men can deal with 24 to 25 tons of crop per day.

A more recent development has been the flail type of harvesters. These can cut the crop direct or can pick up grass and similar crops from the cut swath. This is an advantage, as it gives the opportunity either to wilt the crop if it is sappy or to avoid all wilting if it is mature. This can be important in encouraging a good fermentation.

In either case these flail-type machines deliver the lacerated crop direct to a trailer. While they can be very efficient in cutting and collecting large quantities of greenstuff, the problem of how this can best be dealt with at the silo needs careful consideration. Other forage harvesters, which either cut and collect direct from the crop only or which collect only from the cut swath, are available and may have advantages over the flail type for particular circumstances, but with these there is, of course, not necessarily the same choice in regard to wilting the crop.

Silage from arable crops

Sugar-beet tops. There is usually about a ton of sugar-beet tops available for each ton of sugar-beet sent to the factory. It is generally most economical to feed these tops off on the land once the beet have been cleared. Where this cannot be done, because the land is needed for cropping or the crop is too heavy to be used in this way without serious waste, ensiling some of the tops can be well worth while. It is essential, for a good fermentation, that the tops should be clean when they go into the silo. It is generally best, therefore, to take particular care while harvesting the beet that the tops which are to be ensiled are kept really clean; in most seasons it will be the earliest lifted tops that can be got off the land and into the silo in a really clean condition and without too much dead leaf, which does not ensile well.

Green pea haulm. Green pea haulm from canning or freezing crops can provide a very useful medium protein forage. This haulm is often rather wilted by the time it is available for ensiling and it then needs either to be chopped or to have thorough tractor consolidation in a pit or clamp if serious overheating is to be avoided. It is not necessary to use molasses or other additive with this material, which can be available for ensiling during the midsummer months, depending on the varieties grown and the dates of planting.

Kale. Of the tillage crops specially grown for forage, kale is by far the most important. Because it is capable of producing very large tonnages per acre, kale directly grazed by the stock is the next cheapest food to grass itself and it can provide fresh cheap forage in most years up to year-end. Though with ' Thousand Head ' kale, grazing after Christmas may be possible in some years, the risk of frost is too great to make it safe to depend on kale, and particularly ' Marrow Stemmed ' kale.

Kale ensiles relatively easily and when big crops are grown it would often be better to ensile any surplus that is likely to be uneaten before the New Year. It is important to make arrangements for the crop to be ensiled in September or early October, while the crop is clean and conditions for collection are good. If left until there is dead leaf in the crop, due to frost or age or until any weeds in the crop have died, or if ensiling is delayed until conditions are poor for ensiling the crop in really clean condition, the chances of getting a satisfactory fermentation are much reduced. Mature kale will need chopping, but will not need any additive in the silo. Some forage harvesters will chop kale as they collect it, but if field conditions are uneven or the machine is set too low there is risk that a good deal of soil may be mixed with the greenstuff to the detriment of the silage.

Kale for silage can, in favourable conditions, be taken as a catch crop. For example, if sown in June or early July, after an earlier crop has come off the land, it can produce up to 10 tons of greenstuff per acre by late September or early October. Alternatively, if sown in March or early April, and well manured, it can produce a worthwhile crop by late June, and if Italian ryegrass, trefoil or a red clover mixture is sown at the same time as the kale, this can provide a useful aftermath for late summer grazing. The land in either case can be ploughed for autumn-sown corn or, if the seeds mixture take is suitable, this can be left to provide a further silage cut in the following spring.

Young kale crops of this type, having stems no thicker than a finger, can be ensiled without chopping. If the soil is firm enough, the crop can be cut by a mower and picked up with a buck-rake. It is a watery crop at this young stage, but it has a high protein content and molasses should be used. Provided sufficient heat is allowed to develop in the silo, it can make a good and very palatable silage.

Rape. This is another forage crop which is sometimes used as a cover for seeds or as a catch crop after early potatoes, or after picking peas or after the early ploughing of a seed hay stubble. If used as a cover for seeds, rape is generally grazed at a young stage, but if there is more growth than can be dealt with by grazing it is better to convert the surplus into silage than to let it become too strong and so run the risk of killing the seeds. Sowing date may be at any time from April to July, depending on its purpose, so that it may be available for

Photo: Shell

Rationing out silage from a sodium metabisulphite clamp. The clamp is topped with a limestone seal

silage from July to October. Rape can make good silage, but, being very sappy, it is very important to get a temperature of at least 100°F in the silo and the addition of molasses for young leafy crops is necessary to obtain a good fermentation.

Maize. Maize is not widely grown, but in the south-eastern counties it sometimes provides succulent autumn forage. It is a warmth-loving plant, so heavy or wet soils, which warm up only slowly in the spring, should be avoided. It is also susceptible to frost, so it should be sown after serious risk of frost has passed and for green feed or silage it should be harvested before severe autumn frosts occur. White 'Horse Tooth' maize, which is vigorous, but rather late maturing, has been the most commonly grown variety, but for silage a quicker-growing type which can produce well-developed cobs and a higher dry matter content in the time is more desirable.

Varieties of maize

Work recently carried out by the A.R.C. Unit of Experimental Agronomy at Oxford has indicated that several varieties are available which, though less showy, are earlier maturing and capable of producing a similar amount of dry matter per acre; this makes them more suitable for silage. Wisconsin 275A, Wisconsin 416 (which is seven to 10 days later than 275A) and Wisconsin 341A (which is up to a month earlier than white 'Horse Tooth') are three hybrid varieties which can be quoted as types. The last, W.314A, is probably a bit too late to reach the optimal stage for silage in all but the most favourable conditions here in Britain. More recent work suggests that Caldera 401 and 402, which are of the W.275A type, Pioneer 395 and 396, which are of the W.416 type, and Pioneer 382 and 388, which are of the same maturity group as W.341A, would all be good for silage.

Maize responds well to generous manuring. Sowing 1½ to 2 in. deep, at about 30 to 40 lb. per acre, in rows 18 to 30 in. wide, is normal. The width of row chosen may be decided by the type of machine that is to be used for harvesting.

The aim should be to leave about nine to 12 plants per sq. yd., *i.e.* with 18-in. rows, five to six plants per yard run and with 30-in. rows eight to 10 plants per yard run of row. Some of the newer forage harvesters are able to harvest maize for silage and deliver the crop in chopped condition into trailers.

Cereals and cereal pulse mixtures

Mixtures of cereals with peas or beans or tares can be used for silage making and autumn-sown mixtures, cut early in June, followed by a bastard fallow, may be a cheaper alternative to roots on land that needs cleaning. Sometimes mixtures containing rye and oats and tares are used, but it is generally best to have only one cereal, as the rye is generally earlier than the others, so that either the rye is too old or the other cereal has not had time to contribute much when the crop is cut. The contribution that a legume can make is often not very great, particularly if the crop is cut at a young stage. Unless one is sure that the legume is really likely to make vigorous growth, it may well be best to sow a cereal alone and to manure it really heavily, knowing that for green forage or silage the crop will be cut before lodging need be a serious problem.

It may be that the correct policy to adopt on some farms is to reduce hay production to the absolute minimum and depend mainly on silage; on other farms it may be that silage should be used just to get better control of the grass and to reduce haymaking to the right amount to ensure good quality. Silage may also be an aid in dealing with the first cut of a red clover seed crop, where taking a hay crop might make the seed harvest too late. Silage can be a means of conserving by-products or of utilising the ground for catch crops for fodder without upsetting the main cropping. It can also be used to provide opportunities for cleaning ground without a full fallow and without the hand labour entailed in root growing. It has a useful place on most farms where stock are kept to produce meat or milk.

There is no doubt that silage could play a useful part on many farms where it is not now used. Apart from its value as a fodder, the practice of making silage from grass, from arable crops, or from arable crop by-products, can be used so that the problem of providing the fodder required really does fit in with the other farm needs.

Good Haymaking

It has been found that the most digestible parts of a crop are lost during haymaking, and the reduction in food value is much greater than is suggested by the loss in dry weight.

Under average conditions and management, 40% of the starch or energy equivalent and about 33% of the protein equivalent of a crop are lost during haymaking. There is also a serious reduction in vitamin content. Under bad conditions and management loss of nutrients is often over 50%. Good management under favourable conditions could reduce this loss to 10%.

Six main points in the production of hay of a high nutritive content are given by *The Agricultural Gazette* of New South Wales:

1. Cutting at the correct stage – when nutriment is most evenly distributed throughout the plant. In wheat this stage is reached two days after flowering; in lucerne, when one-tenth of the field is in flower or when the buds begin to swell on the crown. As any crop matures its protein content falls and its fibre content rises.
2. Drying rapidly, to reduce the breaking down of nutrients through continued respiration in plant tissue.
3. Drying evenly, to avoid excessive loss of nutrients in some portions before the rest is dry enough to store.
4. Stacking or storing in shed as soon as the hay is sufficiently dry.
5. Minimising loss from leaching by rain; rain falling on dry hay will quickly wash out digestible nutrients.
6. Reducing loss of leaf, which is more nutritious than stem. Loss of leaf is more serious in clover or lucerne than in cereal hay.

The Pumice Lands

In a previous issue (WORLD CROPS, 1957, **9**, 226) an account was given of the rehabilitation of the 'badlands' of North Island, New Zealand, which was being carried out as a combined operation. Many great blocks of previously unused land in the pumice areas have now been developed under this scheme and about 100 new farms a year are being established in these areas.

What was once useless and infertile fern and tussock country has been converted into green pastures and in a recent report the farms are officially described as 'prosperous holdings'.

Pasture Grasses and Legumes in Northern Ireland

Grass provides about three-quarters of the nutriments consumed annually by livestock and, as livestock and livestock products make by far the largest contribution to farm incomes in Northern Ireland, the outstanding importance of the crop is evident.

PASTURE of good quality will supply the nutriments necessary for full milk production from all except the highest yielding cows and for maximum live weight gains in fattening cattle and sheep. In addition to these considerable advantages, grass is by far the cheapest stock food at the farmer's disposal. It has been computed, for instance, that the cost per unit of nutriment supplied by grass is only about one-fifth of that supplied by purchased meals. Obviously, therefore, the consumption of these alternative foods should be reduced to a minimum; and they should be used for cattle or sheep only when grass is not available in sufficient quantity. Fortunately, the climate and soil of Northern Ireland are eminently suitable for high grassland output and the farmer who is prepared to treat grass as a crop is assured of a full return for his money and labour.

Factors of production

Maximum output from grassland depends on three factors: (1) the presence of the right kinds of plants, (2) the fertility of the soil, and (3) the management of the sward. The sowing of suitable seeds mixtures to obtain the right kinds of plants in the sward is of fundamental importance. However, unless the fertility of the soil is maintained at a high level and the sward is properly managed, the sown species of grasses and clovers will not persist. Therefore, vegetation, fertility and management are complementary factors and, if any one is neglected, full output will not be obtained.

There are 2,150,000 acres of land under crops and pasture in Northern Ireland, in addition to 675,000 acres of rough grazing. Over 80% of the former area is under grass, and of this 30% is in swards less than five years old and the remainder in pastures and meadows over five years old.

Vegetation on the newly sown fields reflects the constitution of the seeds mixtures sown. These swards are generally dominated by perennial ryegrass, frequently with lesser quantities of Italian ryegrass, cocksfoot, timothy, rough-stalked meadow grass, white clover and red clover. Under the traditional farming system, which too often implies inadequate manuring and management, sown grasses tend to die out and after a number of years the swards become colonised by unsown indigenous kinds, such as bent, Yorkshire fog and rough-stalked meadow grass. Recent research work has shown that the dying out of sown grasses and clovers and the incursion of indigenous species, although common in temporary pastures all over the country, is not inevitable and can be arrested almost completely by adequate fertilising and good management. The characteristics of the principal sown and indigenous herbage species are described below:

Perennial ryegrass

Perennial ryegrass is the principal constituent of the great majority of seeds mixtures sown in Northern Ireland and, in conjunction with white clover, it can provide a pasture sward which is regarded generally as the ideal at which to aim. This grass grows well on almost all soils which are adequately manured, but lacks persistency in poverty-stricken and in waterlogged soils. Like all grasses, its nutritive value varies according to its stage of growth, but, generally, it is very palatable. It is a strong competitor and establishes itself rapidly.

Grass seed trials

Usually, when sown in pure culture, perennial ryegrass will out-yield the other common permanent grasses. New strains of this species have become available in recent years and these show marked variations in plant type and in growth characteristics. They are divided mainly into early strains and late strains.

Italian ryegrass

This grass is short-lived, usually dying out towards the end of its second season, but, under conditions of high fertility, it will persist longer if judiciously grazed and not allowed to run to seed. The great agricultural value of Italian ryegrass lies in its capacity for early spring and late autumn growth, in its marked responsiveness to dressings of nitrogenous fertiliser and, consequently, in its capacity to produce a very high yield of herbage. Formerly, it was customary to include Italian ryegrass

in general purpose mixtures intended for hay and permanent pasture. However, it has been found that when this is done the Italian competes excessively with the other components of the mixture, which, consequently, often fail to establish themselves and to make a full contribution to the sward. The present recommendation is that certain swards for special purposes should consist solely of Italian ryegrass with, possibly, a little white clover and that it should be excluded normally from mixtures containing other grasses. It demands high fertility and will not give satisfactory results on poor, unfertilised soils.

Approximately 10,000 acres of Italian ryegrass are grown annually for seed production in Northern Ireland. For this purpose the seed is sown under a cereal nurse crop and harvested in the year following the removal of the nurse crop. Italian ryegrass swards from which the seed crop has been removed should not be allowed to remain in pasture and should be ploughed for further crop production.

N.Z. short rotation ryegrass

This grass, produced in New Zealand, was selected from crosses between Italian ryegrass and perennial ryegrass plants and has characteristics intermediate between those of its parents. Its vegetative growth conforms more to that of Italian ryegrass than to that of perennial ryegrass; a sample of the seed resembles a mixture of the seed of the parent stocks, some seeds being awned and others not. Growth begins rather earlier in spring than perennial ryegrass, but not quite so early as Italian ryegrass. Similarly, in so far as persistency is concerned, it is intermediate between perennial and Italian. During recent years New Zealand short rotation ryegrass has been grown by a number of farmers in Northern Ireland, but no conclusive evidence of its superiority over Italian is yet available. It may be used to replace all or part of the Italian ryegrass in mixtures for short-term leys, but a high proportion should not be included in mixtures for long-term leys.

Timothy

Timothy is an extremely palatable and nutritious grass, but has the disadvantage of being slow in establishment. Normally, it is included in seeds mixtures as a secondary component, although on occasions it has been sown in conjunction with clover for the production of timothy meadows on peaty land. In more recent times timothy/white clover swards have been advocated for special conditions, mainly to provide grazing during periods of low productivity on ryegrass pastures. A special feature of timothy is that it does not tiller to the same extent as many other grasses and, therefore, combines well with meadow fescue, another non-aggressive species in the early stages of growth, and with clover. Timothy/meadow fescue/clover swards have become popular in recent years and can be recommended under conditions of high fertility.

Meadow fescue

Meadow fescue, like timothy, is slow in becoming established and does not reach its maximum productivity until the third harvest year. Being a slow grower in early life, it is a poor competitor and seldom contributes much to a sward when sown in conjunction with ryegrasses. On the other hand, it combines well with timothy and when meadow fescue and timothy are sown in equal amounts and the mixture fortified with red and white clovers, the resulting sward is capable of yielding well, particularly in midsummer, when ryegrass-dominant leys are in low production.

An improved leafy strain of ryegrass growing in Northern Ireland

Meadow fescue is tolerant of wet conditions; it is best suited to the heavier types of soils and responds well to generous fertilising. The commercial strains are mainly of Danish origin. They commence growth earlier in spring than the pedigree strains, but vary considerably in this respect and also as regards tillering capacity and leafiness. In general, they conform more closely to the hay type than to the pasture type of plant, but some commercial firms offer seed from specially selected crops having a reputation for earliness and leafiness.

Cocksfoot

Until recently cocksfoot has been sown almost invariably as a secondary component of a seeds mixture in which ryegrass predominates. Special cocksfoot/white clover swards are employed now to a limited extent, the seeds mixture sown containing only these species. Normally a cocksfoot sward does not give high production in the first season of growth. The plants have a deep rooting system and can make satisfactory growth under soil conditions where the growth of other species would be restricted by drought.

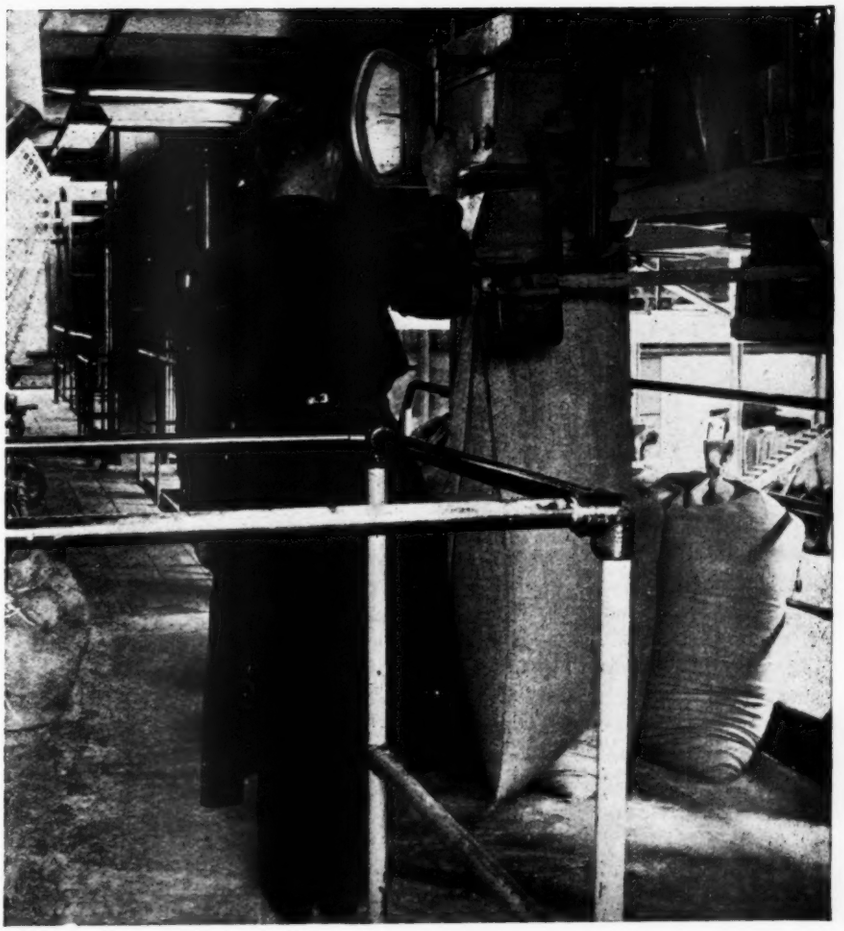
Where sown in association with ryegrasses, cocksfoot tends to form tufts in the sward which are not relished by stock and the proper management of such a sward becomes extremely difficult. This does not apply to the same degree to a pure cocksfoot/white clover sward. The tendency for cocksfoot to be attacked by rust and to suffer from ' winter burn ' is noteworthy.

Rough stalked meadow grass

This is a palatable pasture grass which creeps extensively and gives a close, thick sward. However, under poor soil conditions its productivity is low, and even under average conditions it is generally out-yielded by other useful species. It is very strongly indigenous on most soils in Northern Ireland and, therefore, makes a contribution to the sward even when not sown. It is not included now in the mixtures recommended for sowing, but if, under special circumstances, it is desired to include this grass the seeding rate should not exceed 1 lb. per acre.

Crested dogstail

Crested dogstail thrives on practically all types of soils. In general, it is not so productive as the grasses already described and, where these do well, it should not be sown. For poor, hill land pasture it is a useful addition to the mixture, but not more than about 4 lb. per acre should be included. It is winter green, and under hill land conditions is very valuable for sheep pasture. If properly managed it is palatable, but if allowed to produce seed heads, it tends to be refused by stock, as the seed heads and stems are hard and wiry.



This plant is capable of cleaning ryegrass to the highest degree. In 1957 Italian ryegrass cleaned in a factory at Lurgan attained purities of from 99.6% to 99.9%

Bent

Bent is the main natural indigenous grass in this country and is included with the grasses listed here because it is so widespread in pastures – not by virtue of its qualities as a pasture plant. It has a creeping habit of growth and under bad management rapidly chokes out the better grasses and clovers. It is tolerant of wet and acid soil conditions. It is fairly palatable when well managed, but fails when compared with, say, perennial ryegrass in its lack of productivity, its restricted period of seasonal growth and its tendency to become unpalatable to stock when under-grazed.

Yorkshire fog

Yorkshire fog, another inferior indigenous grass, is prevalent also in many old pastures. Its productivity is not high and its hairy leafage is unpalatable. Its spread is favoured by its free-seeding habit. Natural seeding of Yorkshire fog often takes place adjacent to animal droppings where the herbage is tainted and, hence, not grazed by stock. Like bent, it tolerates wet, acid conditions where the better grasses would not persist.

White clover

White clover is one of the most valuable of pasture plants. Under suitable conditions it not only produces a large bulk of protein-rich herbage, but also supplies nitrogen to associated grass plants through the activities of bacteria which live in its roots. Quantities of atmospheric nitrogen equivalent to a dressing of from 6 to 12 cwt. sulphate of ammonia per

acre per annum can be fixed by clover bacteria under favourable conditions.

The establishment and growth of clover is frequently unsatisfactory, due to shortages of soil nutriments, such as lime, potash and phosphate. The persistency and contribution of white clover is affected also by the timing and intensity of grazing and by the use of heavy dressings of nitrogenous fertilisers. Swards containing white clover are generally more resistant to drought than those without clover.

Red clover

Red clover contains also nitrogen-fixing bacteria in its roots and, as a result, the supply of nutrient nitrogen in the soil is augmented. On soils which suit it, red clover makes a very valuable contribution, as regards both yield and quality, to swards used solely for one or two years' hay or grazing. Sometimes red clover, although sown, contributes little to the herbage; this failure may be due to the soil being too acid, to a shortage of either phosphate or potash or to the seeds mixture containing an undue proportion of aggressive grasses, such as Italian ryegrass. Hard grazing in the first autumn or winter is often essential to establish a desirable ratio of clover to grass.

There are two main groups of red clover strains, broad-leafed or early red and late-flowering red. Plants of the former group start growth sooner and flower about a fortnight earlier than those of the latter group. The early strains do not produce such high yields of hay as the late-flowering types, but they are more productive in aftermath. Most of the broad reds disappear after the second season. The late-flowering reds, which persist into the third season, are more leafy and withstand grazing better than the broad reds.

Alsike clover

Alsike clover is more resistant to acid conditions and generally persists for a longer period than red clover. It is hardy and over-winters well, but is less productive than red clover. Its inclusion in mixtures is not recommended except under conditions where red clover does not succeed.

Seeds mixtures

Because herbage species differ very markedly in size of seed, in power of establishment and in ability to withstand competition, the vegetation of a sown sward does not reflect exactly the composition of the seeds mixture sown. Over-complicated mixtures of seeds should be avoided, particularly under conditions of high fertility, since the secondary components of the mixture will be found to make little contribution to output.

The modern tendency is to use relatively simple seeds mixtures which in an extreme case may consist of only one grass and one clover species. However, although recommended seeds mixtures have become simplified as regards the number of species included, they are tending to become more complex by reason of the inclusion of a number of different strains of the same species. Another important modern trend is that, generally, the same seeds mixture is not recommended for all fields on a farm, but, rather, a variety of mixtures to produce swards suited for particular purposes.

Abstracted from leaflet No. 40, Ministry of Agriculture, Northern Ireland.

Photos : Hurst & Son Ltd.

Coming Events

Royal Show. The British Royal Show is to be held this year at Bristol from 1–4 July.

Grassland Agronomy. A course on this subject organised by the British Council in co-operation with the Grassland Research Institute is to be held from 6–19 July. Its aim is to bring together specialists from all parts of the world to discuss the techniques of grass and animal experimentation as well as the wider field of increased production from grass.

Rural Extension. The sixth International Meeting on agricultural extension and rural home economics is to be held at Wageningen, the Netherlands, from 7–31 July.

Seaweed. The 3rd International Seaweed Symposium will take place from 13–19 August in Galway, Ireland. Particulars may be obtained from University College, Galway.

Water Resources. A four-day conference on hydrology and water resources in East and Central Africa is to be held in Kampala from 18–22 August. Among matters to be discussed will be absorbitive losses in canals; silt transportation; sedimentation; hydro-geology (ground water); catchment area research; and hydrological instrumentation and measurements. The Secretary of the Conference is Lt.-Col. S. P. Fearon, of the East Africa High Commission, P.O. Box 30005, Nairobi, Kenya.

Botany. The IXth International Botanical Congress is to be held in Montreal, Canada, from 19–29 August and some 4,000 participants are expected from all parts of the world. Dr. W. P. Thompson, President of the University of Saskatchewan and international authority on genetics of cereals, will preside, and the programme will contain papers and symposia related to all branches of pure and applied botany. Enquiries should be addressed to the Secretary-General, Dr. C. Frankton, IXth International Botanical Congress, Science Service Building, Ottawa, Ontario, Canada.

Genetics. The Xth International Congress of Genetics will be held at McGill University in Montreal, Canada, from 20–27 August. The scientific programme will consist of symposia, invited papers, contributed papers and demonstrations, exhibits, panel discussions and special meetings, covering all branches of genetics.

Agricultural Economy. The Xth International Conference of Agricultural Economists will take place at Mysore City, India, from 24 August–4 September.

Land Development. A second International Seminar on Land Development for Agricultural Uses is to be held at Wageningen, the Netherlands, from 25 August–12 September. Enquiries and applications should be sent to The Secretary, International Agricultural Study Centre, 1 Generaal Foulkesweg, Wageningen, the Netherlands.

General Science. The annual meeting of the British Association for the Advancement of Science will be held in Glasgow from 27 August–3 September. Subjects to be discussed in the Forestry and Agriculture Section include host-parasite relationships; forest tree seed; integration of agriculture and forestry in land use; horticulture; and the application of science to hill farming problems. Further particulars may be obtained from the Secretary, British Association, Burlington House, Piccadilly, London, W.1.

Digitaria smutsii, *after 14 months in the field and showing the regrowth after one cut*

Eragrostis curvula, *after 14 months in the field and showing the regrowth after one cut*

Grasses for Grazing in East Africa

THE Department of Agriculture has been opening up cattle ranches in the hitherto unproductive areas of grass and light bush in the east of Zanzibar island. In these areas (the 'uwanda') the vegetative climax under present-day conditions of occasional fire is either light bush or grass. The bush is dominant where the underlying coral comes through to the surface, but this is replaced by grass wherever there is more than a few inches of soil overlying the coral.

Indigenous grass

The dominant grass is *Heteropogon contortus*, known in Swahili as 'kipundi'. It is a grass which is characterised by a short growth period to maturity and by the production of sharply pointed 'seeds' which are unpleasant to walk amongst and can be dangerous to stock. Following fire and rain after a dry period the grass quickly produces a flush of green leaf which is palatable to stock. But within a short period – about six weeks – it will have matured and dried on the plant. The amount of growth is not great, for the plant rarely exceeds 18 in. in height. The 'hay on the root' is not liked by stock, perhaps because of its unpleasant spikelets, and is consequently of little value; it must be burnt off and fresh growth encouraged.

Imported grasses

Since *Heteropogon* is relatively unproductive and has the disadvantages mentioned, a programme of introducing and testing other grasses has been started. The following grasses have been employed in the first tests:

From South Africa:

Digitaria swazilandensis.

Digitaria smutsii.

Panicum kabulabulaensis.

Panicum makarikariensis (*P. coloratum*, var. makarikariensis).

Panicum maximum.

From Tanganyika (Mpwapwa):

Chloris gayana (Rhodes grass).

Cynodon plectostachyum (star grass).

Cenchrus ciliaris (African foxtail).

Setaria sphacelata, *after 14 months in the field and showing the regrowth after one cut*

From Uganda:

Brachiaria brizantha.

Also *Chloris gayana* (ex-Kenya and ex-Knoetze).

Bromus catharticus, var. Nakuru.

Cenchrus ciliaris (Molopo strain and selection T.4464).

Setaria sphacelata (ex-Kazungula and Koolbank).

Eragrostis curvula (Ermelo strain and Tanganyika strain).

With the exception of *Brachiaria brizantha*, all the grasses were obtained as seed and were sown in nursery beds. As was to be expected from experience in other countries, germination of the Makarikari *Panicum* was almost negligible, while poor results were also obtained with the other *Panicums*. *Bromus catharticus* also germinated with difficulty. The strains of Rhodes grass germinated particularly well, as did the *Eragrostis* and the *Cenchrus* from Mpwapwa. The other species germinated reasonably well with careful tending. Although the information thus obtained is useful, it is not conclusive, for the seed was not produced under Zanzibar conditions.

To determine growth under the conditions in which the grasses would be utilised, the young plants were set out on the 'uwanda', competition from weeds and other grasses being kept to a minimum. They received the full benefit of the main rains, but shortly afterwards suffered a rather

A ' uwanda ' area, before clearing and grazing, showing light and heavy bush. The grass is Heteropogon

prolonged dry period. After some four months the surrounding natural pasture of *Heteropogon* had seeded, leaving dry stems which were valueless as pasture. At this time the *Cenchrus* strains had seeded freely and were beginning to dry off. The Rhodes grasses were in the same position, but it was noticeable that the Mpwapwa strain had produced a greater weight of material than the others and was remaining green for a longer period.

A profuse growth of Brachiaria brizantha

The Kazungula *Setaria sphacelata* grew rapidly to a height of 5 ft., seeded irregularly, and the self-sown seedlings quickly established themselves amongst the neighbouring species.

The *Brachiaria brizantha*, which had been obtained as setts from Uganda since the species is known to be difficult to establish from seed, grew remarkably well, reaching a height of 4½ ft. It maintained a strong flush of green growth throughout the dry period and showed little sign of dying off after setting seed. As has been experienced elsewhere, however, the seeds shed easily, apparently before they were fully mature. *Eragrostis curvula* grew strongly in thick clumps to a height of 1 ft., but showed signs of drying off and had not flowered after five months in the field.

This first step in the programme has demonstrated that some five or six of the imported species can grow on the ' uwanda ' and can, in a limited period, produce a weight of fodder which is far in excess of that produced by the local *Heteropogon*.

A preliminary analysis, which it is proposed to repeat at monthly intervals in order to obtain a full range of growth stages, gave percentages of protein ranging from 5.3% to 11.1% for seven of the imported species, while *Heteropogon* gave 3.4%. There is every possibility, therefore, that they will be of greater value than the local grass.

Abstracted, with permission, from the Bulletin of the Department of Agriculture, Zanzibar, for the quarter ending 30 September, 1957.

Cattle seeking shade from the midday sun under a solitary tree

Pasture Cultivation

Many pasture fields have swards of inferior grasses and weeds with a thick mat of old grass on the surface of the soil. Such pastures have a short grazing season and a low stock capacity.

The mat of old grass prevents air and moisture from reaching the roots of the pasture plants as well as hindering the uptake of the fertilisers and lime needed to sweeten the herbage and increase the productivity of the pasture. Consequently, a vital factor in the improvement of grassland of this type, if it cannot be ploughed and sown down following a rotation of crops or reseeded directly to grass, is surface cultivation to tear up the mat of grass and to aerate the soil. Following such treatment the fertilisers and lime applied will have the maximum effect, as they will readily reach the roots of the plants. Surface cultivation has the further beneficial effect of encouraging the pasture plants to produce fresh shoots and new succulent growth in spring, due to their being stimulated by the physical effect of the treatment as well as by the fertilisers.

Several satisfactory types of harrow, specially designed for grassland cultivation, are now available. If, however, the area under grass on a particular farm is not sufficient to justify the expense of procuring a special implement for the purpose, surface cultivation may be carried out quite efficiently with a disk harrow or with a well-sharpened and weighted zig-zag harrow.

If rushes are present, they should be cut close to the ground before harrowing begins. The harrowing must be done thoroughly and, when finished, the field should have a brown rather than a green appearance. If there is a very extensive accumulation of foggage present, it may be necessary to remove some of it to enable the harrowing process to be properly completed.

Surface cultivation of grassland is most effective if carried out when the land is soft, but not too wet. During the early part of winter and before growth commences in spring are suitable times to do it.

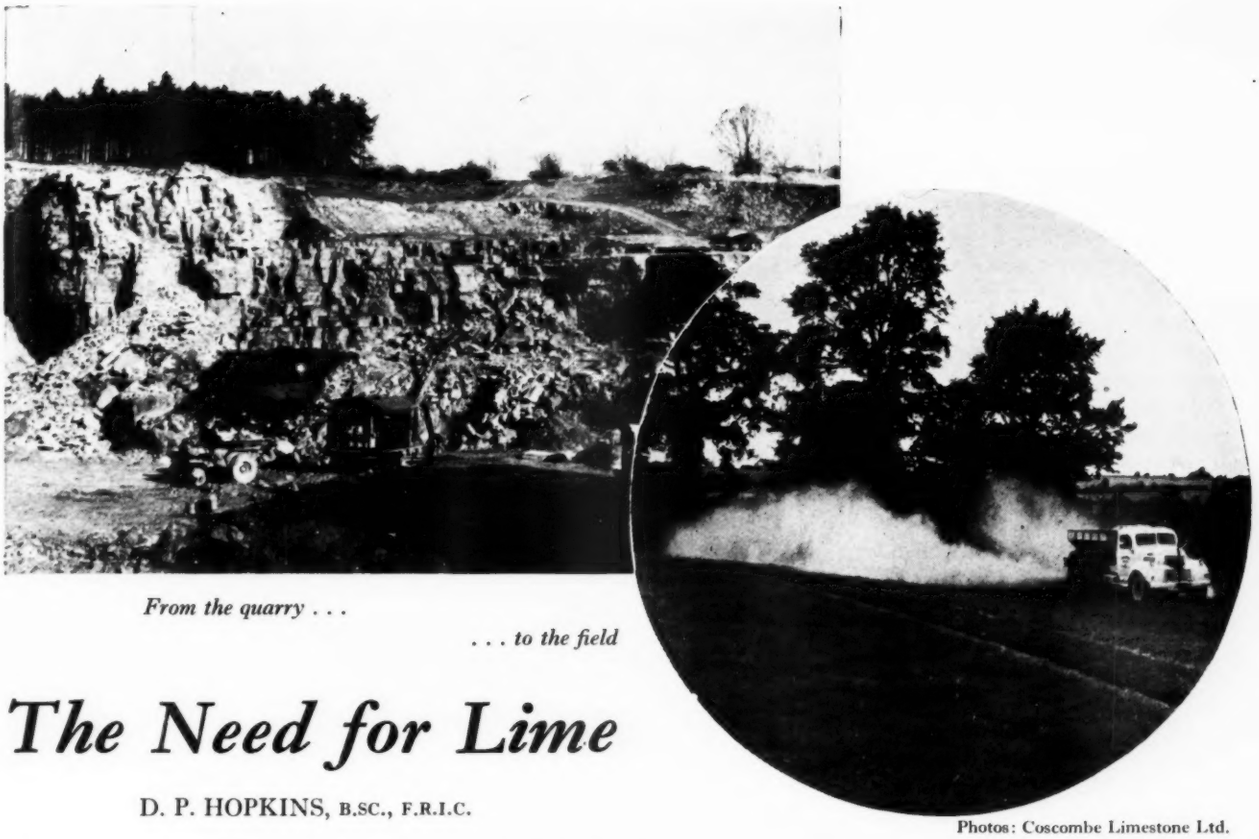
If pasture so treated contains little or no clover, a further improvement in its quality and productiveness may often be obtained by sowing a small quantity of wild white clover seed on the harrowed surface in spring. About 1 lb. of seed per acre is sufficient for this purpose and it should be mixed with sand or, preferably, with some perennial ryegrass seed to facilitate the sowing of such a small quantity of seed evenly over the entire area. The land should be rolled immediately after the seed has been sown.

New Palms for Old

Coconut replanting in Ceylon has made good progress since 1949. In 1954 about 9,000 acres were planted with selected seedlings and, in 1955, seedlings sufficient to plant 13,000 acres were supplied to the public.

However, the demand for seedlings still exceeds the supply and the Coconut Research Institute is stepping up production with the ultimate object of providing seedlings for planting 16,000 acres a year.

The coconut crop and export of coconut products last year have been the highest on record. Statistics compiled by the Coconut Research Institute have shown that there has been an increase of 78% over the crop of 10 years ago.



From the quarry . . .

. . . to the field

The Need for Lime

D. P. HOPKINS, B.SC., F.R.I.C.

Photos: Coscombe Limestone Ltd.

The stimulating effect of applications of lime on the productivity of the soil is partly due to the reduction in the acidity, partly to the improved tilth, and partly to the fact that calcium is one of the most important elements needed by plants and animals

THE subject of liming is a difficult one to discuss, for to many people it is today a stale subject to be taken for granted. Such familiarity, unfortunately, tends to breed neglect rather than contempt, for under-attention to lime in discussions or in articles about soil fertility tends in turn to cause under-attention to its use. Yet it is a serious omission in any scheme designed to create greater soil productivity – intensified fertiliser use, resown grassland etc. – if the elementary need for liming to correct ' sourness ' or soil acidity is overlooked. The fertiliser advice of 20 years ago was generally accompanied by references to the need for checking the lime requirement. These reminders of the obvious seem to be much less frequent now.

Because progressive farmers today are more knowledgeable about nitrogen, phosphate and potash requirements, it is assumed that they automatically consider the need for lime. For at least two reasons, this is dangerously unsound. Some farmers, reading and hearing so little about lime, draw the incorrect conclusion that modern practices have made liming less necessary. Secondly, young farmers today are several generations removed from the time when liming was regarded as one of the few essential operations in agriculture; with these younger men, the instinct to remember liming is not so deep-rooted.

Causes of soil acidity

This prelude serves at least as an apologia for re-stating some of the fundamental points about liming. Lime, in one form or another, is the cheapest alkaline material for reducing soil acidity. The rate at which soil acidity increases varies from country to country. In the warmer and drier climates acidity development is usually slow; in climates such as those of north-western Europe, acidity development is more rapid, and therefore the need for lime is more common.

The main cause for this difference is that nothing reduces the lime reserve of a soil more rapidly than rainfall, because the ' wash-out ' of lime is far greater than losses by utilisation. Thus, in Britain the wetter soils of the western side of the country are far more acid than the drier soils of the eastern side. Liming such soils is somewhat comparable to trying to fill a pail with holes in it – and it is therefore fortunate that liming materials are usually not expensive.

Other factors also contribute to soil acidity. The gradual decomposition of vegetable matter and humus in the soil produces various acids, known collectively as humic acids. Some commonly used fertilisers also leave acid residues – notably sulphate of ammonia. But these are quite small influences towards acidity compared with the annual removals of lime by rain.

However, a slight amount of soil acidity is desirable even to the point of being essential. The medium through which nutrients are mainly transmitted to crops is the soil solution, and this must be acid if it is to extract nutrients from the soil and also from many of the applied fertilisers. But if the soil solution is too acid, it also extracts antagonistic elements,

particularly iron and aluminium. Iron is certainly needed for crops in relatively small amount, but if an excess is present it precipitates phosphate out of the soil solution; aluminium does the same without having the virtue of being a plant nutrient.

Liming needs to be a careful operation. It is certainly not a 'swamping' operation by which the acidity is totally neutralised, leaving a large excess of lime for the future – for an alkaline soil can be less productive than an acid soil, for its alkaline soil solution will then be unable to extract nutrients from the soil's reserve etc. The application of too much lime is, in fact, wasteful and may be harmful.

Nor is the acidity a simple property to assess, for, effectively, what matters is the acidity the soil passes on to the moisture it holds. This is influenced by the complex mineral and organic constituents of soils, acting rather similarly to the chemicals used in water softeners.

Lime to correct acidity

Today, when soils are sampled and tested for lime requirement, it is not so much their acidity that is measured as their '*p*H', which can be regarded as a technical number that expresses the state of acidity in the soil solution. The *p*H of a soil is altered by adding lime, but it depends upon the type of soil – especially on its content of these acidity-regulating substances, mineral or organic – how much lime is needed to bring about a desired change in the *p*H. Just as these substances can control the amount of acidity that soil acids can pass on to the soil solution, so they can also control the amount of alkalinity that added lime can pass on.

A *p*H of 7.0 is neither acid nor alkaline; it represents neutrality. A soil solution with this *p*H would not extract plant foods readily enough. A 'more acid' *p*H of between 6.0 to 6.5 is ideal for most crops (*p*H figures go down as acidity rises). At this *p*H range there is maximum extraction of essential plant foods, minimum extraction of less desirable elements, and favourable conditions for beneficial soil bacteria. Broadly, a soil's requirement of lime is the amount that will bring its *p*H into this 6.0–6.5 range.

If all this sounds rather complex and unsatisfactory to the layman, let it be said that the *p*H of soils and the ease or difficulty with which their *p*H may be corrected are easily measurable by soil sampling and analysis, especially when the results are interpreted through the experience of regional advisory officers. So long as liming is preceded by such testing there is no risk of over-liming

There are, however, what might be called short-cut tests. Thus, the *p*H of a soil can be roughly estimated by the colour changes of certain dyes (indicators) when these are mixed with the soil; an older type of test is to mix soil with hydrochloric acid and see if it 'fizzes', the 'fizzing' being the action of the acid on calcium carbonate, thus showing the presence of a large reserve of lime. Such simple tests can be helpful in showing whether or not lime is required, but they do not show *how much*; nor can they, except by additional guesswork, measure the soil's capacity for *p*H change.

Lime as a conditioner

These considerations of acidity and the *p*H of the soil solution do not provide the whole case for liming as a fundamental soil fertility operation. Lime is also an excellent soil conditioner. The heavier soils with sizable clay contents are made more workable by liming. Briefly, this is because calcium-containing clays are less cohesive than others. It might be thought that if a lot of lime is required to shift a soil's *p*H into the optimum 6.0–6.5 range, much of this lime is wasted; but with a clay-type soil a good deal of the lime is first taken up by the clay and, although this checks the direct action of the lime upon soil acids, it brings about most desirable physical changes in the nature of the clay, enabling the soil to drain better, to be ploughed more easily and probably earlier. On lighter soils, lime does not function so much as a soil conditioner, but it can still be beneficial in preventing the surface-capping of seedbeds.

Lime as a plant food

Lime is also a rich source of calcium, one of the major plant and animal nutrients. It can be argued that calcium in non-alkaline forms is present in soils and is also provided in certain fertilisers, *e.g.* superphosphate, rock phosphate. However, an acid soil is most likely to have become acid through the washing-out of its lime reserve, and so it must also be suspect for a deficiency of calcium.

There is insufficient space to deal with other beneficial aspects of liming, such as the greater susceptibility of certain crops (*e.g.* clovers, most root crops, lucerne, barley etc.) to soil acidity, or the greater risk of some soil fungal infections (*e.g.* finger-and-toe disease) in acid soils.

Forms of lime

So far the 'portmanteau' word 'lime' has been used to cover all liming materials. Strictly, lime (CaO) is a processed form of calcium carbonate ($CaCO_3$), abundantly found in most countries as the minerals, chalk or limestone. Kiln-burning drives off carbon dioxide and converts calcium carbonate into calcium oxide; this means that a ton of lime has more acid-reducing power than a ton of the original chalk or limestone.

But the chalk or limestone itself can be finely ground and in this form it reacts with the soil acids. Is the action of ground carbonate slower than that of lime? Lime is more soluble in water and for that reason its action should be quicker; on the other hand, chalk or limestone can be very finely ground, which means that the surface area of a dressing is in more contact with soil than is usually the case with a lime dressing. Lime's greater solubility in water means that if heavy rain follows a dressing, lime has the bigger risk of being washed out before it has fulfilled its purpose in the topsoil.

There are various waste limes from industry, and marls and sea sands, containing carbonate, which are also used for liming. Their 'lime-value' per ton is very easily measured by analysis, and rates of dressing per acre can then be calculated according to these 'lime-values' for any recommended lime requirement.

Need for magnesium

Not all the natural limestones are forms of calcium carbonate; some are considerably associated with magnesium carbonate, which differs very little from calcium carbonate, except that it is rather slower in action.

This relative slowness created prejudice against magnesian limes and limestones in the past, but the important fact that magnesium is a major nutrient for plants and animals was passed over. Magnesium is needed for the formation of chlorophyll, the green

A field of lucerne. The middle strip has not been limea Photo: Fisons Ltd.

pigment of foliage and the ' agent ' for photosynthesis. Today it is realised more and more that when a deficiency of magnesium is suspected a cheap and easy remedy is to use magnesian limestone instead of ordinary lime or ground limestone.

An important instance of this is concerned with the serious form of animal tetany, known as hypomagnesaemia – a disorder whose onset is sudden and often fatal. It is due to a disturbance of magnesium-handling processes in the animal's body. Although not directly due to magnesium shortage in diet, the higher the magnesium level in the animal's bloodstream, the less is the risk when this metabolic disturbance starts. On farms where hypomagnesaemia has been experienced the use of magnesian limestone on pastures and leys is a valuable palliative, if not a preventive, against further outbreaks.

Light and sandy soils are often poorly off for magnesium, and heavy-feeding crops may well benefit from magnesian limestone even though the acidity or *p*H measure for lime requirement is small. Thus, more use of dolomite (calcium magnesium carbonate) is being currently developed, *e.g.* in Ceylon for tea, rubber and coconut plantations.

Dangers of over liming

Finally, are there not prejudices that operate against the fuller use of lime in farming? There is, indeed, an old saying in more than one country to the effect that ' lime makes father rich and son poor ', and it is still cited, even though it belongs to the era of guesswork about soil fertility. Modern testing for soil *p*H and lime requirements has made nonsense of this old saying, which is simply a hangover from days when liming principles were inadequately understood.

The first few limings of an acid soil will indeed result in impressive increases in crop yields because the more favourable *p*H makes it possible for the plants to extract more of the plant-food reserves in the soil. Continued liming can have two adverse effects – (1) by over-liming it will then produce a soil solution unable to extract certain essential elements; (2) the reserve of major nutrients in the soil can ultimately become exhausted, unless manures or fertilisers have also been applied.

Some modern farmers also underrate the benefits of liming because the results with the first crop are less spectacular than they are from fertiliser dressings. But the benefit has to be judged over a succession of crops, and with leys or pasture it must be judged qualitatively – in terms of the botanical composition – as well as quantitatively.

Again, because some crops can withstand soil acidity much better than others, *e.g.* oats, potatoes, it is sometimes wrongly assumed that acidity is, in fact, ' good ' for them. Nevertheless, a recent survey of the costs of crop diseases in the West of Scotland rated ' acidity damage ' as one of the most expensive troubles of oats.

The general opinion of delegates to an OEEC soil fertility conference in 1954 was that great areas in Western Europe still had acid soils, whose productivity could be greatly raised by liming, and this made ' the lime problem one of the most important problems of present-day agricultural practice '. Nothing yet has made liming a less important operation, and nothing justifies the tendency to treat it as a dull and old-fashioned subject. It has perhaps suffered from having much less modern research attention than has been given to fertilisers.

Technical News

Articles in the July issue of some of the other journals of the Leonard Hill Technical Group include the following:

Dairy Engineering.—'Some Implications of Automation in the Dairy Industry ' by I. A. Howard; ' The Function and Application of Refrigeration in the Dairy Industry ' by H. Burley and E. J. Perry; ' Large-scale Processed Cheese Plant – Kraft Foods Ltd.'; 'Advanced Mechanisation – the Way to Automation '.

Chemical & Process Engineering. – ' The World's Newest Paper Board Mill '; ' Mechanisation in the Laboratory ' ' Packed Fractionating Columns ' by Prof. S. R. M. Ellis and J. Varjavandi.

Food Manufacture. – ' Jam-making the Modern Way ' – a description of automatic jam plant installed in a German factory by Robert Kellie & Son Ltd.; ' The Problem of Improving Nutritive Value ' by Prof. H. D. Cremer.

Atomics. – 'Accelerated Electrons for Commercial Irradiation ' by F. R. Paulsen, PH.D.; ' Cadmium Sulphite for Radiation Detectors '.

Paint Manufacture. – ' Indian Paint Industry Progress ' by K. K. Sarin; ' Fundamental Studies of Adhesion ' – researches conducted in the U.S.A.

Automation Progress. – ' Recent Progress in the Automation of Steel Making '; ' The Design of Electrically Controlled Machine Tools ' by F. Koenigsberger.

Production from the Hills

Account of the Winter Meeting of the British Grassland Society

IN opening the winter session, the President of the British Grassland Society, Mr. A. S. Gray, gave a challenging address on the subject of 'A Practical Farmer's Experience of Grassland Improvement'. He confessed that there were 'shoals of points on which he was both puzzled and ignorant'. He admitted that direct answers cannot be given to many of these problems, but he wondered whether scientific caution was not a little too much in evidence and whether opinions should not be expressed a little more forthrightly.

He first raised the important issue of the lack of any generally accepted terminology or standard for the measurement of output. The term 'Utilised Starch Equivalent' had been suggested by his predecessor, Dr. Sanders, but since then there had been no progress in the matter. Another basis of measurement was based on 'Dry Matter' estimations, while Cow Days, Milk Gallons and Meat Output were other alternatives commonly used. He himself thought that the Utilised Starch Equivalent, or B.G.S. Unit, was more flexible and comprehensive than the others and that it provided a basis for converting one type of yield expression to another. He was sure that the more widespread use of a recognised system of measurement of grassland output would lead to improved grassland techniques.

He next raised the question of the correct rate and balance of fertiliser applications, which he was aware was a very complex subject, but the average farmer, he said, was left in doubt by these complications. He urged that positive recommendations even if only based on the estimated requirements for balanced applications would be less wasteful than leaving the farmer to make his own guess.

Many farmers, he continued, are worried by the 'Clover-Nitrogen' story and would like to know more about it, because, in his opinion, too much clover in a sward depressed output considerably. The factors were perhaps the smothering out of grasses and unpalatability; but conversely, swards with too little clover often lacked vigour. He was inclined to think that even with high nitrogen dressings, it was still possible to preserve a suitable balance of clover. The real answer appeared to lie with the price of nitrogen fertiliser.

The optimum degree of defoliation of a pasture by grazing was another matter on which many farmers were somewhat bewildered. The grass plant needed a rest to allow a new growth of leaf and to build up nutrients in the root system in preparation for seeding, but how, he asked, did this work out in practice. Grassland instruction failed to emphasise sufficiently that this was a matter for compromise, because if the fertility level was high, it was possible to take all sorts of liberties; this was not the case at lower fertility levels. Winter grazing, too, was a matter for compromise, as continued grazing could have a devastating effect on the following season's yield, since the early season grass growth was poor. The possibility of a following drought was another consideration and the sward balance also an important factor. Tighter grazing helps the clovers, whereas long rests, especially during periods of maximum growth, will help the grasses. The prostrate type of perennial ryegrass sward seemed to need tight grazing – also a matter for compromise.

The conflicting opinions about seed rates and seed mixtures were also very puzzling and he felt a sense of frustration on the problem of the conservation of grass for winter feed but he hoped he would ultimately find the correct technique to get near-grazing yields of milk with silage, produced from early-cut grass.

The correct management of grasslands was a matter which called for the maximum skill and art of the farmer who needed the help of the Advisory Services to straighten out all these conflicting considerations.

The following are extracts from the papers presented:

Hill Soils and their Production Potential *by E. Crompton (University School of Agriculture, King's College, Newcastle-upon-Tyne).*

The better agricultural land in lowland Britain is associated with natural Brown Earth soils, and the presence of similar soils on the better parent materials at quite high altitudes shows that the climate has not prevented a good organic cycle with its associated useful herbage. Where such patches exist amongst the rough grazings they are far more productive than the surrounding areas, in spite of their excessive grazing.

Here and there in the uplands one occasionally finds well-managed fields at high altitudes, and the yield from them is often remarkably high; even on the marginal pastures surrounded by broken-down walls, and with a sward which has reverted to heather or Nardus, one can usually find beneath the present acid surface mat the remains of a mull humus topsoil with evidence of former earthworm activity, indicating clearly to any who care to dig that this was once reasonable grassland.

Until recently, however, it was difficult to counteract the effects of continuous leaching. Drainage, liming, cultivation and some control of grazing did make a big impression in certain areas, but lack of phosphate, and even of potash and minor elements, was often a crucial limitation. Since the use of artificial fertilisers became generally accepted, there has not really been the economic incentive to reclaim the moorland areas on any large scale and the moorland margin has crept back into formerly cultivated areas.

Where scientific fertilising has been attempted, however, there has generally been a remarkable response. Milton and Davies, following the work of Stapledon, have shown the transformation of species composition and of yield of hill swards which are possible by lime and fertilisers in moderate dressings; and the later yields of 4½ tons of dry matter of high mineral content from land at 1,000 ft.

altitude reveal how far improvement can go by surface treatment and controlled grazing. The transforming effects of re-seeding or surface-seeding, in addition to fertilisers, are too well known to need more than passing mention.

It is true that war-time measures met with varied results. Many were successful, but the very urgency of the moment led to an emphasis on short-term methods which were often disappointing, and have in some cases discouraged further efforts. Direct re-seeding for example gave extremely variable results. On soils of reasonable drainage, without too much surface mat, the improvement was often spectacular and lasting, but where drainage was poor, or where a peaty mat was ploughed in, rushes frequently became dominant and the farmer was disappointed. But the real fault lay in a lack of adaptation of technique to soil condition.

There is no doubt that with carefully chosen methods the zone of moderately intensive farming can be extended far up the foothills, and with modern fertilisers and techniques of application the fertility of much of the hills themselves can be increased. Economic and social factors are the main limitations, but the present emphasis on the value of grass, following the great advances in knowledge of its management, may attract attention to uplands again.

Current research is showing just how very responsive grass is to moisture, and there can be no doubt that the rainfall of the growing season in most of our lowlands is far below the optimum for grass production, and, in the south and east, even for many other crops as well. The rainfall increases with rising altitude, and, although the temperature falls, it seems probable that the potential grass production at 1,000 ft. may be greater than in much of the drier lowland. To what extent the increased moisture supply actually compensates for the detrimental effect of lower temperatures, we do not know. At the moment the limitation in the uplands is almost always low soil fertility, but it is now possible to go far towards correcting this. It is, therefore, most desirable to assess the effects of the climate of the uplands more exactly.

In the last two years, research students at King's College, working under the guidance particularly of Mr. F. Hunter, have put down small trial plots on a wide range of soils at different altitudes ranging from 500 to 1,600 ft. in Northumberland and North Yorkshire. Here 16 sites have been re-seeded and, adjacent to 11 of them, the natural sward has been similarly limed and fertilised to a level, suggested by soil analysis.

Young Highland cattle on a hill pasture in Scotland

Production from the natural sward has varied greatly; but, where grasses were dominant, yields have often been doubled by fertilisers, which included 4 cwt. of nitro-chalk, and have been between 2 and $3\frac{1}{2}$ tons of dry matter per acre. The adjacent re-seeded plots have varied between 3 and $5\frac{1}{2}$ tons per acre. It is not easy to detect any obvious correlation with altitude; the $3\frac{1}{2}$ tons dry matter produced at 1,600 ft. and several figures of over 4 tons at more than 1,000 ft. are sufficient evidence that high yields are possible even in the second year after ploughing the raw moorland.

Most of the soils are either podzolised or peaty, and the very high responses suggest that fixation of the added fertilisers may be slight. Certain soils, which are inherently poor in plant nutrients, but highly responsive to fertilising, may be more valuable today than certain chemically richer soils, which happen to have poor physical properties. Improving chemical fertility is now relatively easy compared with modifying soil physical conditions.

But any method of reclamation or improvement should consider the kind of soil. For instance, many Gley* soils in the uplands owe their wetness to seepage, which carefully placed cut-off ditches or drains could remedy at no great cost. In others, the gleying is of the surface-water type which makes them particularly hazardous to plough and especially to re-seed. In some soils the surface wetness is the result of the sponge-like effect of the surface mat and will ultimately disappear as this peaty mat is oxidised under conditions brought about by lime and fertilisers. In any plan of improvement, in fact, an essential ingredient is a soil survey which will not only help to decide the best use of a particular area but may also help to reduce costs by defining the properties of a soil and its requirements more precisely, and by making possible the confident application of experience gained on the same kind of soil elsewhere.

The Direction and Problems of Research in Hill Pasture Improvement *by Dr. R. F. Hunter (Hill Farming Research Organisation, Edinburgh, Scotland).*

The H.F.R.O. is one of the youngest research organisations of Britain. The organisation has brought together workers who are interested in hill farming research and who now find the facilities to carry out work either not previously attempted or merely at a preliminary stage. It would appear that the present and the future economic situation of hill farming, and this irrespective of any political

* Gley: where there is permanent or seasonal waterlogging, anaerobic conditions produce grey or blue-grey soils, containing iron in the ferrous condition.

changes with their consequent effect on subsidy policy, points unequivocally towards the necessity for cheap methods of pasture improvement and a close study of the probable return from any method of improvement or amelioration.

Under Scottish conditions, sheep are maintained throughout the year on pastures which are composed of various proportions of different plant communities. Each plant community has a distinctive pattern of greater or lesser seasonal utilisation; they differ in the intensity to which they are grazed, in their reaction to management practices and in their agricultural potential. No two hills are identical in the proportions in which these communities occur and hence each presents its specific problems. The degree of utilisation, as between different communities, can be altered, within limits, by herding and the use of sheep or mixed sheep and cattle grazing. Ecological changes can be initiated by fencing, muir-burning, manuring, draining and bracken cutting, the direction and rate of these changes being affected by their interaction with the incidence of grazing and its concomitant treading and manuring effects.

In arriving at the best procedure to manage a hill pasture, the farmer or shepherd has to answer questions set by the specific feature of the hill or heft in question. Is the hill suitable for cattle; what will be the long-term effects of the cattle on the vegetation and the sheep stock; what is the best frequency of muirburn to adopt; if liming is to be done, then on what areas of what plant communities; what will be the effect of this if the heft suffers a subclinical cobalt deficiency; would it be advisable to herd the sheep to this or that area at different times of the year; could utilisation be improved by fencing off an area?

The answers to such straightforward questions are derived from ecological studies and studies of the naturally occurring hill species and plant communities constitute the core of our work.

Changes, when they take place, are exceedingly slow. The effect of lime may not be fully manifest until seven years after application, the effect of cattle grazing probably longer. The flock being in regular ages and breeding its own replacements you have to allow for a period sufficiently long for the succeeding flock to be bred under the changed management and this period is five years. This is because the sheep's life as a lamb and hogg affects its subsequent performance as a ewe.

We are considering starting an experiment on the effect of manuring hill pastures with lime and phosphate on the stock performance and output. The problems we are meeting in designing this experiment will illustrate the difficulties encountered in hill pasture studies. We have under consideration a heft on our Cheviot hill station. Six years ago cattle were put on this heft and it was fenced. The sheep stocking was reduced from 1.4 acres per sheep to 1.7 acres per sheep in 1953 and the area of 250 acres carries 26 cows and calves from May until October or November. The cattle grazing has made the sward suitable for manuring and we would like to commence a manurial experiment, top-dressing about 40% to 50% of the total area.

This sounds uncomplicated until you set up certain minimum criteria which you feel ought to be satisfied before you are entitled to begin.

Can you divide the area into two equal parts? This is impossible for vegetational and topographic reasons, and a simultaneous comparison is, therefore, excluded. Within the limits of annual variability could you regard the system as being stable? No, the performance of the stock has consistently improved over the last four years and the numbers of stock could now be increased. This is the effect of cattle grazing and higher winter feeding.

Table 1
Lamb production on a large-scale trial at Pwllpeiran, Wales
(Years 1945–51 inclusive)

	Unimproved	*Improved pastures sown with*	
		Com. strain	*Bred strain*
Average number of ewes grazing per acre	1.5	2.4	2.6
Number of lambs reared per acre in six seasons	7.3	14.7	15.7
Average weight per lamb	40.8 lb.	50.8 lb.	53.5 lb.
Weight of lamb produced per acre in six seasons	298.0 lb.	747.0 lb.	840.0 lb.
Total value of lamb produced per acre in six seasons	£12 7*s.* 6*d.*	£36 3*s.* 0*d.*	£42 3*s.* 0*d.*

Some Present-day Problems in Farming Hill Land, *by A. J. Davies* (*National Agricultural Advisory Service*).

During the long period of general economic decline for British agriculture between the 1870s and the 1930s, there was large-scale emigration from the hill areas, and a rapid decline in the standard of farming. With the onset of the second world war, attempts were made to redeem the position and correct the omissions of two generations or more. During the war years, there were the hill sheep and hill cattle subsidies, lime subsidies, ploughing-up grants and marginal land schemes. The provisions of the Hill Farming Act of 1946, followed by the Livestock Rearing Act of 1951 and more recently by the 1956 Hill Farming Act, seek to implement this policy of rehabilitation more firmly.

There are a number of inherent factors which influence both the productivity and the profitability of upland farms in Britain. Of these probably the most important at the present time is the size and layout of the holding. On far too many, the hill proper is completely unfenced or, if it is fenced, it is usually left in one unit. On the other hand the enclosed fields are usually much too small, and are costly in hedging and fencing.

The main line of attack is quite clear – an increase in the size of holdings through amalgamation. Whether or not we like it, and whatever its social implications, the tendency must be towards larger units and a more convenient settlement.

The basic need is to increase the level of total production; on such extensive systems of farming there is a tendency for the same pattern of costs

Below: Lambs reared on reseeded hill pasture

Above: Lambs reared on the same acreage of an unimproved native hill pasture Photo: Welsh Plant Breeding Station, Aberystwyth

to be incurred each year; the only means of raising profitability is to increase the returns from livestock or livestock products.

On the small unit the only answer is to increase its size; on the really poor holdings, with rocky outcrops, the solution seems to be a closed economic link with lowland holdings. Both are long-term measures.

The first essential is to improve the better quality land on the holding; only in this way can one increase the stock carried and alleviate the shortage of winter food.

Table 1 shows clearly the economic advantages of improving this type of land as well as the importance of using good strains of herbage plants.

The shortage of winter food is the factor, above all others, which restricts the development of hill farming. The cost of providing winter fodder has become an extremely important item. Recent figures produced by the Agricultural Economics Department at Aberystwyth for the two years 1954–55 and 1955–56 show that wintering comprised one-third of the total expenditure in the costs of a hill flock.

The preparation of foggage or winter grass can only be practised on farms where there is a substantial proportion of in-bye or enclosed fields. Our experience in Wales suggests that in broadcast swards cocksfoot is not very satisfactory for late winter, *i.e.* January/February grazing, while timothy or timothy/meadow fescue leys were much better, being far more winter green.

It is generally agreed that it is very desirable nationally to increase the contribution of meat from the hills and many claim that this can only be achieved by increasing cattle numbers. There are two main ways in which cattle may be made to play an increased part in the hill farm economics. Either (1) the hills can be used as summering grounds for stock from lowland farms or (2) the hill farm must carry and winter a small breeding herd.

The other important aspect is the provision of winter fodder. Again, there are two alternatives: either the making of silage on the hill farm or the purchase of hay from lowland areas. On the hill farm proper there is, at present prices, much to be said for the buying in of hay. This system has certain merits: (1) there should be a better chance of buying a good quality product, and (2) if the purchase is made in July the price should be reasonable. There should not be the same deterioration in the productivity of sward on the enclosed land and it should enable a greater head of stock to be kept on farms, so many of which tend to be on the small side.

On the better hill farms there seems to be an undeniable case for silage making. Here there are usually better buildings for wintering and more enclosed fields to make provision for winter.

Every committee or commission that sits on this subject agrees that afforestation is vital for the well-being – both economically and socially – of our uplands.

Great stress is being laid these days on the integration of forestry and agriculture. There is no doubt that in earlier days the Forestry Commission, in pursuit of maximum timber production, planted trees on sheltered rough grazings which were previously capable of providing the rather scarce winter keep of sheep. They thus created problems of narrow and difficult access to the remaining unplantable high grazings.

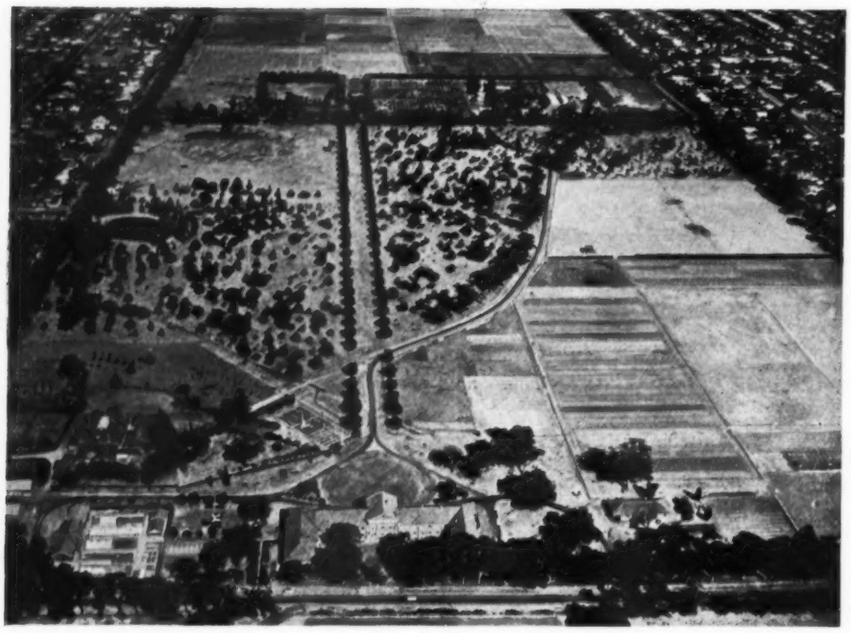
Much more needs to be learnt about the integration of forestry and agriculture in the hill areas and there is a vital need for a number of experimental or demonstration farms where this very important subject could be investigated. The Scottish Hill Farming Research Organisation is studying the problem at Lephinmore and I hope it will be part of the investigation work on the Ministry's new Experimental Husbandry Farm at Pwllpeiran in Wales.

The present and future economic situation in hill farming points to the need for cheap methods of pasture improvement; at the same time, the diversity of management systems, vegetational types and stocking intensities, found in hill farming, requires research to be itself diverse.

War Against Unseen Hosts

The work of the Waite Research Institute of Australia

JOHN LOUGHLIN



A PIONEER pastoralist in South Australia, Mr. Peter Waite, presented to the University of Adelaide some 30 years ago a 300-acre estate, four miles out of Adelaide, consisting of grazing and agricultural land, together with a mansion house and a trust fund.

The simple philosophy which prompted this endowment was that man could not exist like a nomad, eating out the land and moving on, but must call on science to help him to renew the soil for future generations. From that has stemmed the scientific investigations now being tackled by the Waite Research Institute, ranging from the workings of the humble earthworm to the breeding of viruses.

Despite its close proximity to the ever-expanding city of Adelaide, the Institute has been able to preserve its lands intact and its pastoral setting has remained unchanged. The handsome laboratories still stand amid the picturesque eucalypts of the foothills, with the wooded slopes of the Mr. Lofty Range rising behind.

Scientists engaged in the satisfyingly constructive task of aiding mankind to obtain a better living from the soil, face a challenging array of problems in Australia, one of the world's most arid continents.

Aims and objects

The Institute began its work in 1925, when the estate was converted into an agricultural research station primarily for the investigation of problems affecting the production of farm crops and the improvement of pastures.

The main trend of its work has been influenced by its general directive to undertake research on problems of plant science having a bearing on the agricultural and pastoral industries of South Australia, *i.e. the problems of farming in the winter-rainfall region. There is a region* 80% *of which has an annual rainfall of less than* 10 *in.* and is suitable only for pastoral pursuits. Over the rest of the State – the area devoted to agriculture – the rainfall varies from 10 in. to 30 in. a year.

The winter rainfall is suitable for raising cereal crops, but, except in the higher rainfall districts, the summer is too dry for sown pastures of the British species. One of the primary aims, therefore, is to develop a system of cereal agriculture and pasture management that will make the most of the winter rains and at the same time be suitable for a semi-arid climate.

As these conditions are also to be found in many parts of Australia outside the tropical and sub-tropical zones, the results of research work at the Waite Institute have a wide application.

The newly appointed Director of the Institute, Dr. J. Melville, is former chief of the Division of Grasslands in the D.S.I.R.O., New Zealand. Dr. Melville succeeded Dr. J. A. Prescott, who was Director from 1938.

Search for new species

It is perhaps some measure of the effort demanded from man to wrest a living from the Australian continent that its crops and sown pastures depend entirely on planting material and seeds introduced from other countries. The search for new species goes on ceaselessly. Thousands of grass plants from all parts of the world are being tried out in the hope of finding species of economic value in the Australian environment.

Development of pastures from familiar British grasses has naturally been limited to the higher rainfall districts of southern Australia, but climatic conditions in the agricultural areas of the State of South Australia and some neighbouring districts over the borders are akin to the climatic region around the Mediterranean and in California.

Hardier species of perennial grass plants are needed for this environment. The Mediterranean countries are therefore the scene of most of the activities of the Australian expeditions.

Three parties have brought back

large consignments of seeds and plants comprising thousands of different varieties. These are first being sown under quarantine conditions and are then being raised under grazing conditions in the hope that one or two useful plants will be found.

It would perhaps be too much to hope for anything approaching the success that followed the chance introduction of subterranean clover many years ago. This pasture legume originated as a natural pasture plant in the Mediterranean basin, where, however, it is not used as a sown pasture.

It has since been developed in southern Australia as a sown pasture and now covers over 20 million acres. In the development of immense areas of poor soil in the good rainfall belt of South Australia it is today the main ally of the farmer and scientist.

Approaching it in importance, however, is the new strain of strawberry clover, introduced from Israel and already established over a wide area in South Australia.

Trace element deficiencies

Pasture research has led to the discovery of the mineral deficiencies of the soils – deficiencies of nutrient elements such as phosphate, copper, zinc and molybdenum. The grey leached soils of the wetter south-eastern districts of South Australia have been found to be greatly deficient in phosphate.

After pastures are successfully established, the next step has been to demonstrate more effective practices in the utilisation and management of the pastures and the raising of livestock.

The Institute is at present trying to find out what deficiency is responsible for the poor growth of young sheep even on improved pastures during the summer months, when the feed is dry.

Another investigation concerns the function of earthworms in maintaining the fertility and chemical structure of soil – in effect, what happens to the soil when it passes through the intestine of the worm. Surprisingly little work has hitherto been done on this problem.

Plant breeding

Plant breeding research is basically important to the two main cereal crops of South Australia – wheat and barley.

Working in collaboration with Sydney University, Waite investigators have succeeded in breeding varieties of wheat, resistant to the Australian strains of stem rust, by crossing the standard commercial variety of wheat with a rust-resistant type. From the resulting hybrids, rust-resistant types are selected and crossed back with the original commercial parent.

Barley growers, maltsters and State departments of agriculture are backing the barley breeding programme. This is aimed at producing an improvement on the single variety, Tryor, which has been grown in South Australia almost exclusively for half a century.

Plant diseases

Waite Institute is playing its part in the efforts of science to combat the many plant diseases caused by fungi, bacteria or viruses and through the investigation of these problems new light has been thrown on some soil deficiencies in South Australia. For instance, grey speck in oats has been found to be symptomatic of manganese deficiency. Wither tip in oats was associated with copper deficiency, and unthriftiness in flax is considered to be due to zinc deficiency.

The Institute is now planning investigations in this field, combining the work of the geneticist, the pathologist and the biochemist.

Virus breeding

The discovery that some plant viruses are nucleoproteans was made simultaneously in 1936 by Prof. W. Stanley, of the University of California, and by Dr. R. J. Best, of the Waite Institute, while working on the mosaic virus of tobacco.

Experiments in genetic properties of viruses are being conducted at Waite with the tomato spotted-wilt virus, which has a world-wide distribution.

In the short period of its existence, the Waite Agricultural Research Institute, of Adelaide, has made very substantial contributions to agricultural science and has fully realised the dreams of the pioneer whose endowment gave it birth.

Studying virus disease of tobacco in a glasshouse at the Waite Research Institute

Right: Dr. Rupert J. Best, head of the virology section of the Institute, where fundamental research on the chemistry of virus breeding is carried out

Perfecting a Crop-Protecting Chemical

THE Technical Department of Plant Protection Ltd. is in some ways unique in the crop protection industry. In most of these organisations, research on new chemicals, work to create new products and biological work to test them, are all housed together. Plant Protection Ltd. have, however, a separate group at the Jealott's Hill laboratories in Berkshire, where research on potential new insecticides, weedkillers and fungicides goes on in association with research and development work on fertilisers. The company also has laboratories at Fernhurst Research Station in Surrey, for the biological testing of products, while the job at the Yalding works and laboratories is to make products and formulations from chemicals, rather than to look for new chemicals, to inspect the production of existing products, to control quality, and to provide information on safe handling, methods of mixing, and the normal technical advisory service relating to the chemical and physical nature of the product.

In recent years, the number of crop protection chemicals has steadily increased and, as their use has become more widespread, so has the need increased for formulation, suited to a wide variety of climatic and other conditions. The preparation and testing of the many and varied formulations therefore assume ever greater importance; and allied to this work is the control of the quality of the chemicals and the determination of possible chemical residues on crops in this country and overseas to ensure the safety of the use of the product and of the consumer of the crop.

The original laboratories of the Yalding works, built 25 years ago, have already been expanded once, but still they were wholly inadequate to cope with the ever-growing volume of work. The splendid new laboratory block, which has now replaced them is still only a part of the Technical Department.

Before the war the main products in the crop protection field were sodium chlorate, sulphuric acid and sodium arsenite as weedkillers; nicotine, derris and lead arsenate as insecticides; lime sulphur, dispersible sulphur and Bordeaux mixture were used as fungicides; organic products – in the form of organo mercurials – were then used only for seed dressings.

Recent developments

Three outstanding inventions have since transformed the scene. In insecticides the chlorinated hydrocarbons (of which gamma-BHC, discovered by I.C.I., is probably the most active) and the phosphorus insecticides have enormously increased the scope as well as the efficiency of modern spraying treatments; in weedkillers, a virtual revolution has resulted from the discovery by I.C.I. of the hormone weedkillers. Since the discovery of MCPA, weed killing has developed in agriculture all over the world – primarily in cereals. The stimulus given by the wide scope of the hormone weedkillers in these crops has also promoted a great deal of new research and has led to the conquest of many other fields. Of the fungicides, synthetic organics were first used during the first world war. A considerable group of organic materials, including both the thiocarbamates and the naphtha quinones, were in use before 1939, but the commercial development of these materials came mainly after the second world war.

Testing a crop-protecting chemical. The product under test is held at constant temperature while air at the same temperature is drawn over the material. The vapour carried away is condensed and absorbed in a suitable medium in the vessels in front of the chemist

Formulation and package testing

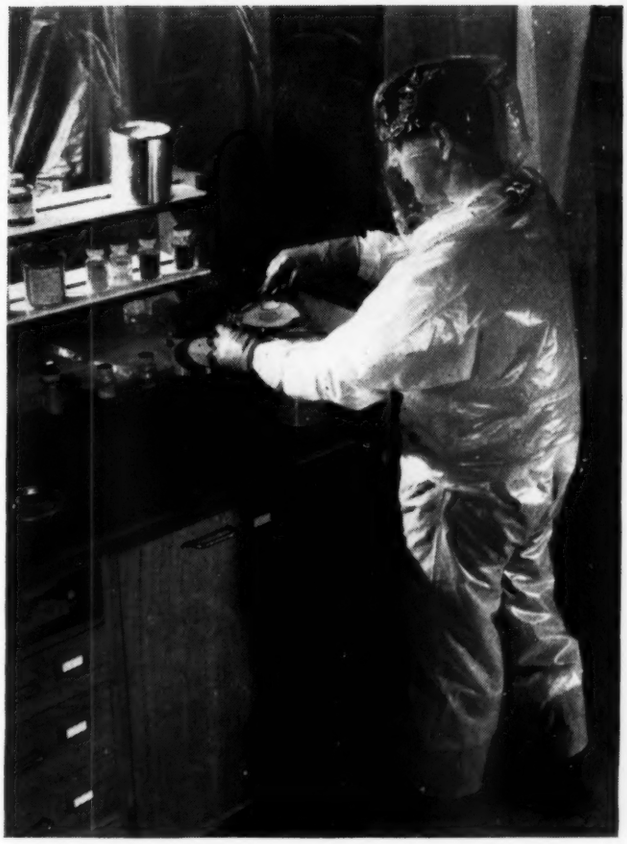
Before the war, if a material was relatively inefficient it was probably cheaper to use a little more active ingredient than to try to improve the formulation of the product. Now, tremendous attention must be paid to formulation and formulation testing. If the formulation is improved, it is possible to use much less because the product is more effective. The physical properties can be improved by the use of emulsifiers to increase its miscibility with hard or soft waters – as the case may be.

Constant temperature and refrigerator rooms are also necessary for testing the stability of formulations, containers and packages under varying climatic conditions and the rooms at Yalding are controlled at 25°C, 75% R.H. (temperate); 37°C, 90% R.H. (hot humid tropics); and 50°C dry heat (torrid). The refrigerators can run at varying temperatures down to −30°C (arctic).

Toxic residues

The majority of crop protection chemicals are safe to use and no question of harmful residues arises. Certain other chemicals, however, do present potential hazards, and work must be done to ensure the safety of the users of the products and of the consumers of the crops so treated. Before the war, though highly toxic compounds were in use, *e.g.* lead arsenate and nicotine, long experience had taught farmers how to handle them. Now, a rapidly expanding field of use demands much careful scientific work to assess the necessary precautions and advise on them before experience has slowly built up safe practices.

The Intelligence Section is responsible for liaison with the Ministry of Agriculture, Fisheries and Food on the various regulations concerning the toxicity of crop protection products; and for recommendations concerning precautions for their use. Thus the public is protected by the work being done at the new Yalding laboratories both as regards the effectiveness and the nature of the formulation.



The chemist is totally enclosed in a tough, chemical-resistant suit, which is sufficiently flexible to allow free movement. Fresh air is supplied through an airline. The working bench is surrounded by plastic curtains and extractor fans draw off fumes and particles

The Muirfad System

A problem facing hill farmers in Britain is the need for additional winter grazing. Their grasslands need to be extended on to the peatland, carrying heather or even more boggy species of vegetation. It is on such ground that the Muirfad system is proving of value. The heather is burnt, lime and phosphate are applied, and a good seed mixture is surface-sown. The lime kills the heather and the plant residues and the manures nourish the young plants.

According to Dr. R. F. Hunter, of the H.F.R.O. of Scotland, the method is a failure on a grassy sward without the use of a mixed fertiliser containing nitrogen. He further states that the method works, not only for deep peat, but also on highly podsolised soils. These are invariably very acid, with surface *p*H figures below 4.0. Like the peats, they are extremely deficient in phosphates and in other nutrients also, but their free drainage is an important asset.

These podsolised soils are to be found wherever peat occurs over a well-drained subsoil. Beneath the peat is a drab, olive-green horizon, generally a few inches in thickness, which overlies a hard, thin iron-pan, generally less than $\frac{1}{4}$ in. thick. This pan, which is overlain by a mass of roots clinging to its upper surface, has a dark organic surface, beneath which is an almost black metallic-looking layer, merging to a rusty-coloured horizon below.

According to Mr. E. Crompton, of the University School of Agriculture of Newcastle upon Tyne, this rather striking soil owes its origin to the weak weathering, strong leaching and weak organic cycle leading to the development of the acid surface mat, which remains saturated due to the prevailing high rainfall. Conditions below this mat are constantly anaerobic, and the iron is reduced and leached and later re-oxidised in the better aerated subsoil below.

Preventing Spray-drift Damage

In the early part of the year when spraying operations with weedkillers were in full swing, the British Ministry of Agriculture, Fisheries and Food reminded farmers of the serious damage that can be caused if chemical sprays are allowed to drift on to other crops. Horticultural crops and sugar-beet are particularly vulnerable to MCPA and 2,4-D.

A few simple precautions can go a long way towards preventing damage. The chief of these are to avoid spraying in a wind, especially if it is blowing towards susceptible crops, and to have the spraybar as low as possible. A light home-made boom shield also helps.

Full advice and information about the problem is given in the Ministry's leaflet, 'Spray Drift Damage to Crops'. This can be obtained free from local offices of the Ministry or from the Ministry's Publications Branch, Soho Square, London, W.1.

National Silage Demonstration

Comprehensive Display of new Methods and Machinery at Basingstoke

THE National Silage Demonstration, which was held on 300 acres of Hatch Warren Farm, Basingstoke, by the kindness of the owner, Mr. Rex Paterson, was organised by a representative committee working under the chairmanship of Mr. H. G. Huckle, the Agricultural Marketing Manager of the Shell Chemical Co. Ltd. The occasion served to bring together the scientists who have been studying the problems, the agricultural advisers, the manufacturers of the agricultural machinery and chemicals, now used in the production of silage, and the farmers and stockbreeders. On the first day at least 10,000 attended this well-organised and important demonstration.

The proceedings were opened by Earl St. Aldwyn, Parliamentary Secretary to the Ministry of Agriculture and Fisheries, who said:

'It is a great pleasure to me to be here and to see so many of you here taking an interest in this demonstration. As you know, it has been organised as a result of the energy and enthusiasm of the Shell Chemical Co. They have been backed up by the N.F.U., the National Institute for Research in Dairying, the Milk Marketing Board, the National Institute of Agricultural Engineering and by the N.A.A.S. We are grateful to them all, because this job of silage-making really is important.

'Of course, nobody pretends that we have learned all there is to be learned about silage-making. There is still plenty to learn, still plenty of room for ingenuity in contriving better methods. But if there is one thing about which we can be certain it is this: that, over the past 10 years or so, we have made a good deal of progress in the use of tractor power for jobs which in earlier times would have meant a good deal of hard work.

'As you look around the showground you will see a wide array of modern machines, including new types of forage harvesters, which not only make the job easy from a physical point of view, but also make it easier to ensure a good product. The machines themselves are important, but there is more to economic operations than choosing the machine which works fastest in the field or the one that is the cheapest to buy. Studies of the whole silage-making job have shown that there are often big differences in the results obtained by using the same machines in different ways; and last, but not least, it is interesting to note that with silage-making, as with a good many other jobs, there is a tendency for well-organised and properly equipped small gangs of just two or three men to be more efficient and economic than large gangs'.

After hearing the address on 'Silage' by Prof. S. J. Watson, Principal of the Edinburgh and East Scotland College of Agriculture, those present made a tour of the exhibition of machinery and witnessed demonstrations of grass cutting and silage-making, in which the following firms participated:

Buckrakes: F. M. Fleming, Massey-Ferguson Ltd., Midland Industries Ltd., P. J. Parmiter & Sons Ltd., S.K.H. & Son, Taskers of Andover Ltd., John H. Taylor, E. V. Twose (Manufacturing) Ltd.

Forage harvesters: A. B. Blanch & Co. Ltd., The David Brown Corporation Ltd., Lundell (Great Britain) Ltd., Massey-Ferguson Ltd., Mitchell, Colman & Co. Ltd., Silorators Ltd., M. B. Wild & Co. Ltd., John Wilder Ltd., Western Machinery & Equipment Co. Ltd., Wolseley Engineering Ltd.

Green-crop loaders: International Harvester Co. (of G.B.) Ltd., Onneley Implements Ltd., John Wilder Ltd.

Balers: Bamfords Ltd., The David Brown Corporation Ltd., International Harvester Co. (of G.B.) Ltd., Jones Balers Ltd., Massey-Ferguson Ltd., New Holland Machine Co. Ltd., Powell & Co., Western Machinery & Equipment Co. Ltd.

Silage rakes and loaders: F. W. McConnel Ltd.

The Cement and Concrete Association arranged demonstrations of silo wall building and the British Cast Concrete Federation had an exhibit consisting of various types of precast concrete silos.

Grassland Surveys

An investigation into the widespread prevalence of sterility and diseases of malnutrition in cattle in Rhodesia has shown that the main cause was not the lack of grass, but lack of essential phosphates and vitamins in the grass which formed the basic grazing.

This is one instance of the importance to food production of thoroughly understanding the nature and food value of soil cover, especially when it can affect extensive areas and the very livelihood of the inhabitants.

Now, Dr. R. O. Whyte, New Zealand grasslands expert employed by the Technical Assistance Administration of FAO, has completed the first map of the grass cover of the greater part of the African continent, in collaboration with Mr. J. M. Rattray, of Southern Rhodesia. The monumental scope of this work can be judged by the fact that they enlisted the aid of specialists on the vegetation of the Union of South Africa, the Sudan, Tunisia, Ghana and the British, French, Belgian and Portuguese territories in Africa. It is hoped that the map will be ready for publication by FAO during this year. The aim is to co-ordinate and analyse information combined with data on climates and soils. A similar map is planned of the grasslands of Latin America.

The intercontinental value of such studies is brought out by the fact that Dr. Whyte has observed similarities between the grass types found in Africa and those known to exist in India and northern Australia, which will make the work of scientists engaged on similar studies in those countries very much easier and is a step further towards the production of a complete picture of the world's grasslands, with its direct value in increasing world food production.

New Publications

Soil-plant Relationships

By C. A. Black. Pp. 332. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. 1957. 56*s*.

As Prof. Black says in his preface: 'this book covers some of the more important soil-plant relationships with emphasis throughout on soil as a substrate for plant growth'. Too many texts have viewed soils as something to be studied apart from the plants which grow in them. Even though the soil may be a legitimate object of study *per se*, students of agriculture (and they make up the vast majority of students interested in soils) are, or should be, interested primarily in the intimate relationships which exist between the soil and the plant. In this book, soil chemistry, soil physics, soil microbiology (and even pedology) have been used as tools in the elucidation of soil fertility problems.

Unfortunately, the above quotation is only too true in another respect – only *some* of the more important soil-plant relationships are dealt with. Many readers will be disappointed to find virtually no reference to any of the essential nutrient elements other than nitrogen, phosphorus and potassium. It is hardly fair to describe the book as 'a thorough, integrated analysis of the major soil-plant relationships' (as the publishers do) when copper and sulphur are omitted altogether and the remaining nutrients receive only passing mention. With Dr. Black's interest in the mathematical approach to soil fertility problems, it is also disappointing to find this absent with only a few exceptions, such as Dawson's equation for the equilibrium value of soil nitrogen.

Having accepted the omissions and limitations of the book, it appears that the author has done a thorough, workmanlike job on those topics he has chosen to cover. His is a refreshingly different point of view on subjects which have been worked over rather frequently in recent years in a number of soils texts and review papers. He has a critical approach (the style is somewhat reminiscent of Russell's *Soil Conditions and Plant Growth*) which becomes evident in the first few pages, as when he warns against accepting as a general principle that structure influences yield when it may be other factors which influence both. 'Poor' soil structure does not invariably limit crop yields; nevertheless, he has not hesitated to express a definite opinion in many instances when a controversial point is discussed.

The book may be conveniently divided into four sections. Chapter one, on soil composition, is more or less introductory and deals briefly with texture, structure, mineralogy, chemical composition, organic matter and the profile, as related to soil fertility. He does not consider visual examination of the soil profile in the field as enough to predict plant response – many properties which influence plant growth cannot be seen.

The second section deals with selected soil physical properties of particular importance in plant growth. There are chapters on soil water and on aeration. It was most heartening to find the energy concept applied consistently throughout the discussion of soil water, but why go only halfway and perpetrate the error, hallowed by long usage, of expressing free energy in units of stress instead of units of energy? The topics of availability of soil moisture and of soil moisture-root relationships receive excellent treatment.

The third section, dealing largely with physico-chemical phenomena, embraces chapters on cation exchange, soil acidity and soil salinity and alkalinity. These and the chapter on nitrogen are probably the best in the book.

The fourth section is made up essentially of three review articles on nitrogen, phosphorus and potassium respectively. Each follows a rather stereotyped pattern; content in soils; forms in soils; availability to plants; function in plants; supply in relation to plant behaviour.

'Soil-plant Relationships' is a perplexing book – stimulating in that the author's keenly critical mind shows through in much of the material, but disappointing in its many omissions.

A. W. MOORE

Bookshop Service

Books reviewed in WORLD CROPS and all other scientific or technical **books** may be obtained from:

Technical Books,
308 Euston Road,
London, N.W.1.
Telephone: Euston 5911.

Other miscellaneous publications reviewed should be obtained direct from the addresses given.

Land of the Southern Cross

By Bryce Kinner. Pp. 152, col. plates 100, photographs and sketches 500. Melbourne: The Australian Publicity Council. Revised 1958. Price not stated.

This magnificent volume was originally produced to give visitors to the Olympic Games a proper appreciation of Australia, and in this it certainly succeeded. It provides a broad and balanced picture of the natural resources and the industrial potential of this vast continent, and of the way of life of the Australians (see also WORLD CROPS, 1957, **9**, 109).

To readers of this journal the special appeal of this book is to be found in the first 40 pages, which give a profusely illustrated account of the agricultural and horticultural industries and emphasises their diversity, efficiency and size. It is useful to learn that plastic bags are now being used to protect bananas, that vast citrus groves are irrigated on a rotation by a grid of sprinklers, and that vineyards are mechanised and planted on the contour near Adelaide. The value of the book could have been enhanced by the inclusion at the end of an index of the subjects covered by the fine illustrations.

F. C. COOKE

FAO Publications

Co-operatives and Land Use, FAO Development Paper No. 61 of 1957. In many countries, particularly where agriculture is the biggest sector of the economy, the majority of farmers have holdings which are too small for them to receive the advantages of large-scale farming, unless they adopt some form of co-operation. This paper aims at widening people's knowledge as to the success which has attended co-operative farming projects, from the collective and compulsory type to co-operatives which have less comprehensive functions, *e.g.* erosion control, joint pasture management. It is a story covering a mixture of failure and success, and of protracted and costly

experiment. This paper sums up the practical advantages, difficulties and disadvantages which can be expected from adopting one or more of the various land-use types of co-operative. Price 5*s.* or $1.00.

World Forest Products Statistics. This is a 10-year summary covering the years 1946–55 with official and unofficial figures from over 150 countries, revised, where necessary and possible, after checking by the countries concerned. Price 15*s.* or $3.00.

Food and Agricultural Legislation, Vol. VI, No. 3. This volume includes legislation on pasture land in Turkey, land tenure and land reform in Sicily, agricultural tenancy contracts in Argentina and general forest legislation in British Honduras. Price 5*s.* or $1.00.

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British Standards

B.S. 2968 : 1958. *Hydraulic spray nozzles.* This deals with cone and fan spray nozzles for ground crop and tree spraying. It specifies an internal thread on the nozzle for all applications, with one thread for the lance type and one for the boom nozzle, and it provides, wherever possible, for performance interchangeability between nozzles of similar size and type, by laying down requirements for rate of discharge, uniformity of distribution and angle of spray. Although uncontrollable conditions in the field (*e.g.* wind, weather and the terrain covered) are bound to affect performances in practice, by specifying a test for ' uniformity of spray pattern ' under constant conditions, the standard largely nullifies the effects of external variables, so that the performance of all nozzles can be compared with the specified criteria.

B.S. 1495 : 1958. *Agricultural tractor details for light- and medium-powered tractors.* The new publication is concerned mainly with those components which affect interchangeability ('maker to maker ') of power-driven and trailed implements, used with different makes of tractor. The most important are the drawbar, the drawbar hitch and the p.t.-o., for which the standard specifies the design dimensions and relative positions, together with the necessary clearance round the p.t.-o. to ensure the unrestricted articulation of the implement or trailer drawbar. The speed and direction of rotation are specified in respect of the p.t.-o. and the tractor belt pulley. The position specified for the tractor pulley was determined after investigation and ensures sufficient belt clearance when driving various stationary machines at different heights and distances. Interchangeability of front wheels is provided for by specifying the fixing details; and there is a list of recommended tyre sizes.

B.S. 288. *Steel roller chains and chain wheels.* This standard deals with a range of steel roller chains allied to the long pitch chains. It specifies requirements for dimensions, tolerances, non-destructive proof loads to which the product must be subjected, destructive minimum breaking loads for samples, and marking. Other requirements relate to chain attachment plates (dimensions are specified for types K1 and M1) and to chain wheels.

Obtainable from the British Standards Institution, 2 Park Street, London, W.1, price 5*s.* each.

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Department of Agriculture, Ontario

Annual Report: Horticultural Experiment Station and Products Laboratory, 1955 and 1956. III. This attractively produced brochure is an annual report with a difference in that it includes a series of original articles on such widely diverse subjects as peach climates, bud variation in pears, the effects of various soil amendments on grapes (including krillium), a leaf-mould-resistant tomato, breeding of cannery tomatoes, preservation by canning and freezing, Canadian sherry wine, cooking tests of apples and the quality of raspberry juice concentrate.

Horticultural Experimental and Products Laboratory – The First Fifty Years. The Fruit Experimental Stations of Ontario were established in 1906 primarily for the purpose of determining what varieties of fruits were best suited to the different parts of the province. At that time the fruit industry had nothing like the commercial importance that it has today. The Station has since extended its activities to cover all horticultural problems, whether of fruits or vegetables or of ornamentals, and this report is an account of the work done in the period 1906–56, with a complete list of published research papers.

Alabama Polytechnic Institute

Bulletin 310, ' Silage Making Costs and Practices ', is a report on the experiences of farmers in four Alabama counties. The research was undertaken in 1954–55 by the Agricultural Experiment Station of the Institute in co-operation with the Farm Economics Research Division, Agricultural Research Service of the U.S. Department of Agriculture. Their findings in the practice and costs of the harvesting, storage and feeding of silage are set out in detail with tables indicating each stage of the investigation. Obtainable from the Alabama Polytechnic Institute, Auburn, Alabama, U.S.A.

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South Pacific Commission

Technical Information Circular No. 24, 1957, gives an account of the facilities for research in Ceylon, India, Indonesia and the Philippines and it outlines the technical problems in coconut production and the processing of copra.

Technical Information Circular No. 25, 1957, is an account of investigations on the production of hardboards from coconut husks which have been carried out in Indonesia and the information is published for the benefit of other coconut-producing countries.

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Landwirtschaftliches Zentralblatt

A Review of Technical Literature, Section II – Crop Production. Edited by Prof. Dr. Maximilian Pflücke. Akademie, Verlag, G.M.B.H., Berlin. Annual subscription: D.M. 192, approx. £16.

This is a review, in the form of abstracts in German, of the technical literature of agriculture covering both research and practical developments.

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International Code

A Code for the Nomenclature of Cultivated Plants has been drawn up primarily by and for those interested in horticulture, agriculture and forestry. This is being submitted to the 15th International Horticultural Congress, to FAO and to the International Union of Forest Research Organisations for ratification and endorsement.

Copies are obtainable from the Royal Horticultural Society, Vincent Square, London, S.W.1, price 2*s.* 6*d.*

Machinery and Equipment

Forage Harvesting

The Lundell forage harvester can be adapted for a large range of tasks, as it will cut anything from beet tops to corn and kale, and can also be used as a shredder. It is a flail-type machine which can pick up wilted material from a swathe, as well as cut a standing crop with no alteration. The farmer can therefore decide which method to use according to the weather and be reasonably assured of making good silage of 25% to 30% dry matter content.

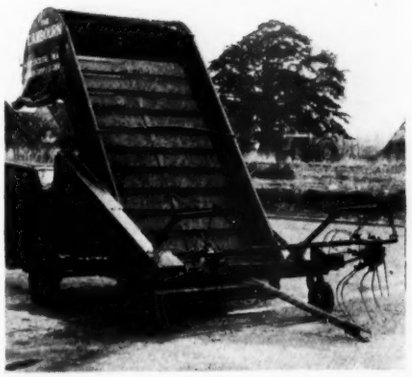
All forage crops of a height from 2 in. upwards may be cut, the height of cut being adjustable between 1 in. and 14 in. The crop is discharged through the main chute either to the rear or to the side, the delivery height being 9 ft. 8 in. Grass leaves the machine chopped and shredded in lengths of 2–6 in. and packs well into a silo – about 65 lb. per cu. ft. Dirt content has been found to be low, estimated at between 2% and 3%. Output is said to be up to 20 tons per hour. The minimum power required is 35 h.p.

For Scrub or Grass

The self-propelled 26-in. Hayter scythe is powered by a Villiers Mk. 25 H.S. 250-c.c., 4-stroke engine, fitted with oil bath air filter and governed to run at a maximum speed of 2,100 r.p.m. The drive to the cutter head is by a heavy-duty endless V-belt through a centrifugal clutch. A chain-driven 3-speed gearbox, having a hand-operated 2-plate clutch, with final drive to a large-diameter split roller at the rear, gives alternative forward speeds to suit varying conditions. Completely sealed dust-proof bearings are fitted to the roller shaft and final drive countershaft. The cutting height is adjustable up to 6 in. by means of a quick-release, lever-operated cam. The Hayter scythe can be used equally well for clearing scrub and for cutting grass to a low level. The controlling handle can be set in various positions to allow direct, partly or fully offset operation. The machine can be fitted with a rear-mounted trailer seat if required.

For Haymaking and Loading

A mechanical aid in the making of haycocks, time-honoured way of good haymaking, is provided by the ' Lambourn'. This is a four-wheeled tractor-drawn all-steel machine incorporating a pick-up elevator, driven off the axle. The elevator picks up the hay and presents it to two men, who stand on a platform on either side of a container which is the shape of a haycock. As the hay falls, they shape it into a cock which slides off the container floor when it is tipped.



The ' Lambourn ', a combined hay cocker and green crop loader

Labour costs are considerably reduced by the use of this machine when dealing with large quantities of hay, *e.g.* 50 acres or more. The normal operating field speed is 3 m.p.h. and the pick-up speed two to three acres per hour. Hay is cocked in less than 2 min. a cock, and the only labour required is two men and a tractor driver.

The ' Lambourn ' can also be adapted for silage crop loading and for pea harvesting. For loading silage crops the haycocking equipment can be removed and replaced with a trailer and the silage crops are loaded direct from the swathes. The change-over takes 15 min. When the machine is used for pea harvesting, the elevator harvests the entire crop and loads it on to quad-pods, which are then off-loaded automatically to dry before threshing.

The Lundell forage harvester is here seen with a corn head attachment, collecting maize for silage

Grain Harvesting

A new and larger combine-harvester, the McCormick International No. 151 harvester-thresher, is now available from the International Harvester Export Co. Powered by a 70-h.p., 6-cylinder engine, and available with either 12-ft., 14-ft. or 15-ft. grain platform, the new machine is suitable for heavy yields and large - scale operations.

The weight of the engine and of the loaded grain tank is largely over the drive wheels to give maximum traction and easy steering. The wheels are in a central position for row-crop

The new No. 151 harvester-thresher, the largest self-propelled combine-harvester of the International Harvester Export Co. range, for large acreage operations

operation. A variable-speed propulsion drive enables the operator to change speed without touching the throttle, shifting gears or affecting the separator speed. Speeds, ranging from approximately 1–15 m.p.h., are provided by a 3-speed transmission.

Special provision is made for quick and easy field inspection, adjustment and service; the engine is top-mounted for ready accessibility and freedom from dust and dirt, and large inspection doors on each side and on top of the machine provide easy access to the interior. More than 70% of all bearings on the new No. 151 are of the sealed, life-lubricated type, leaving only five fittings that require daily lubrication.

Other features of the new machine include a grain platform auger that is set farther back than on most combine-harvesters for improved handling of all crops and straight-in feeding of the cut grain without a beater ahead of the cylinder. The platform is hydraulically controlled and can be set at any height up to 33½ in. above the ground. The operator's platform is located high and on the left, with a good view both to the rear and of the crop line and cutter bar.

Excess Fuel Device

Simms Motor Units Ltd. have introduced a novel excess fuel device for diesel engine starting which can only be used at the time of starting the engine and cannot be 'fiddled' for the purpose of obtaining excess fuel under normal running conditions. This has an important bearing on the problem of smoky exhausts, which can frequently be traced to unauthorised tampering with the excess fuel device to obtain additional fuel for normal running.

The device is fitted to the fuel pump body and operates on the end of the control rod or rack and is operated by turning the knurled outer cover F through 45°. A torsion spring immediately returns the cover to the preset position (see Fig. 1 for illustration). The action of turning the outer cover moves baulk lever D into a position which prevents movement of control rod C towards the excess fuel position. At the same time, stop lever A is moved clear of control rod C and spring-loaded plunger B, which can then move forward until stopped by baulk lever D (see Fig. 2). When the outer cover F returns to its original position baulk lever D also moves, allowing control rod C to move forward into the excess fuel position, stop lever A being held clear by the control rod C (see Fig. 3).

When engine starts, control rod C automatically moves back into the normal running position, stop lever A prevents forward movement of plunger B and stop and baulk levers return to their original maximum fuel position (see Fig. 4). It will be seen from Fig. 3 and 4, that if the outer cover F is not permitted to return to its original position by being fixed in any way, excess fuel still cannot be obtained and so cannot be delivered to the engine under normal running conditions.

New Spray Gun

In the new GunJet No. 22, of Spraying Systems Co., U.S.A., only a few parts of the gun actually come in contact with the chemical sprayed. As a result, the use of costly chemical-resistant materials can be restricted to these few parts, and an overall high-quality gun can be offered at relatively low cost. The gun is supplied in choice of (1) body, cap and tip made of brass with combination brass, stainless and nylon internal valve parts and (2) body, cap and tip made of stainless steel with combination stainless and nylon valve parts. The handle of the gun is a heavy-duty aluminium casting and the trigger is of thick-section plated steel.

The large handle and trigger grip is unusually comfortable, with the trigger giving ample leverage for easy finger operation. The trigger lock for continuous spraying is easily engaged

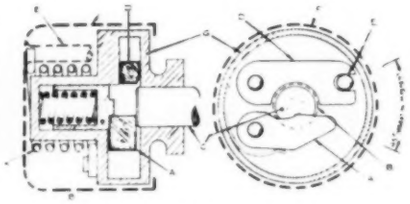


FIG 1

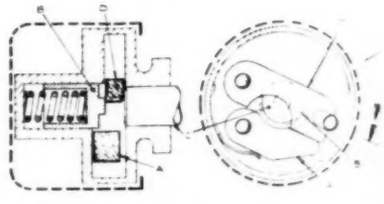


FIG 2

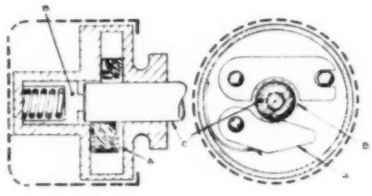


FIG 3

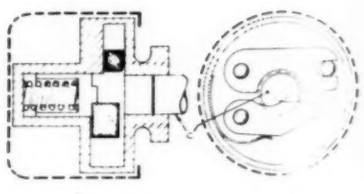


FIG 4

Diagram showing the method of operation of the Simms excess fuel de

by slight pressure of the index finger and is automatically disengaged when the trigger is drawn completely back. Spray control is instantaneous and the gun does not drip, when turned off. The gun is designed for pressures up to 800 lb./sq. in.

A wide range of interchangeable orifice tips in brass and stainless steel is available. They include flat spray, cone jet spray, full cone, disk type and solid stream and they are offered in a wide choice of capacities. Tips are easily changed from one capacity and type to another merely by removing the cap.

Spraying applications include residual spraying of insecticides, livestock spraying, spot spraying in weed control and tree spraying. The gun operates with both manual pump and power-driven equipment.

Preventing Spray Drift

E. Allman & Co. Ltd. have designed atomiser nozzles to reduce the risk of drift during spraying operations. These can be supplied to fit any of their standard machines. The lower the pressure used in spraying, the less likelihood there is of drift, but at the same time complete and adequate cover must be made with a uniform droplet size. The atomiser nozzle minimises the risk of drift, while giving complete and adequate cover at a lower spray bar height.

For Cutting Silage

Hitherto most tools for cutting silage have involved great physical effort on the part of the operator. The 'Drayton' silage knife, manufactured by Edward Elwell Ltd., does the job effectively with a minimum of effort. At a recent demonstration a woman farm assistant managed a cut of about 1 ft. in depth and a man used the full depth of the blade, about 18 in. The cut was clean and decisive, irrespective of the degree of compaction. Apart from eliminating much of the physical effort with the new knife, the depth of the cut that can be achieved also makes for very much greater speed in operation. At the same demonstration, a bale of hay was sliced in half in a matter of two or three minutes and the bale was neatly divided, without any tearing or loosening of the two halves.

The method of cutting is to hold the handle horizontally and allow the knife to cut on the angle during the downward thrust – a slicing action as in the cutting of bread. The blade is extremely sharp and must be kept sharpened with the honing stone provided, and after use the blade should be smeared with jelly. This not only gives protection against rust, but also acts as a deodorant. A leather sheath is also included as a protection from the sharp blade, when the knife is not in use.

The Drayton silage knife and leather safety sheath. The design of the handle avoids the bruising of knuckles

The new GunJet No. 22 showing the large handle and trigger grip for easy control

Allman machines making an application of 12 gal./acre. The unit equipped with the atomiser nozzles (left) *is working at 10 lb./sq. in. with a boom height of 12 in. and the unit equipped with the fan-type jets* (right) *is working at 30 lb./sq. in. with a boom height of 18 in.*

For Drying Hay and Maize

Unless weather conditions have been favourable at the time of harvesting, hay dried in the field will have lost much of its protein content and nutritive value. When this happens a feeding supplement must be added to the hay to make up the deficiency, and this is expensive. With artificial drying, the hay can be cut when the protein content is at its highest.

The Clay crop drier is a method of indoor drying by circulating air through large ducts. It provides a large surface area for the air to enter the hay, eliminates the need for heat, and thus reduces costs. Other advantages are that there is no fire risk and no damage from condensation.

Models are available in five sizes, ranging from a 36-in. fan, driven by a 5-h.p. motor to a 48-in. fan, driven by a 10-h.p. motor. The ducts are built in sections and are easy to assemble. The layout depends on the dimensions of the barn and can be varied accordingly. The wire construction of the ducts ensures the maximum air flow and the fact that they are built in sections means that a passage through, in order to move some hay, can easily be made by removing one section.

This fertiliser spreader has been used to spread sulphate of ammonia on the Sitiawan rubber plantations of Perak, Malaya

The drier can be used for chopped, baled or long loose hay. For chopped hay, a length of 3 in. gives the most efficient drying. Baled hay should be loosely baled – and 50/60-lb. bales are recommended. The bales should be stacked with staggered joints in the same way as the bricks in building a wall. Long loose hay dries very easily and should be spread evenly so that the air passes through the hay uniformly.

Under average conditions about a week is usually sufficient time for the hay to dry, but in humid conditions it will take longer. To check for dryness, the fan should be stopped for five hours and then restarted, and the barn checked for a feeling of warm air. This should be repeated until the fan can be stopped for three days without producing warm air. Since heating is a measure of too much moisture, the absence of warm air is proof that the hay is dry enough for safe storage.

The drier can also be used for maize, with the advantage that the crop can be harvested at 30% moisture and field losses due to shelling are reduced. By harvesting early, losses from corn borer are also practically eliminated. The ducts for maize are slightly smaller and the manufacturers, Clay Equipment Corporation, U.S.A., will be pleased to advise on layouts to suit different types of crib.

Fertiliser Spreading

A fertiliser spreader that has been used for spreading sulphate of ammonia with economy and speed in rubber plantations in Malaya is the ' Quicspread ' produced by Ernest A. Webb Ltd.

The machine operates on the spinner principle from the p.t.-o. of the tractor. An ingenious device allows the driver from his seat to set the spreader to a predetermined density; by moving a control lever he can cut off the supply at headlands and return it without disturbing the density setting. Feed is variable from 1 cwt. to 2 tons per acre.

Two men only are required: one to drive the tractor, the other to open the bags of fertiliser and fill the hopper.

Operating between rows of young mature rubber with 20-ft. avenues, the machine can spread evenly a swathe of 40 ft. by driving straight down one avenue and covering half the avenue on the right and on the left at the same time. Thus by driving the spreader down every alternate avenue, the whole of the ground surface is covered.

Reader Service

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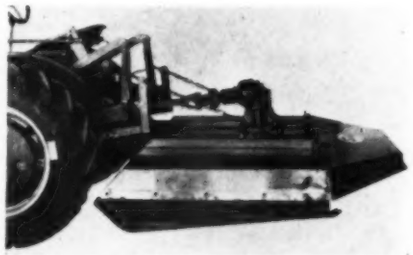

A Gyro-57-LF brush cutter attached with the new attaching brackets to a 'Farmall' tractor

Adaptor Hitch for Mounting Cutters

The Servis Equipment Co., U.S.A., have now made it possible to attach their model E-60-LF clippers and Gyro-57-LF brush cutters to International Harvester ' Farmall ' tractors, models 100 and 130. If the tractor has either 2-point fast hitch or toolbar arrangement, as supplied by the manufacturer, special attaching brackets with cutters can be supplied, as shown in the illustration. These tractors, with a drawbar h.p. rating of from 17 to 20 h.p., have ample power for cutting moderately heavy grass, weeds, maize stalks, sorghum, cotton stalks and similar growth.

Sack Filling and Weighing

The Model 700 bagging scale, manufactured by Burrows Equipment Co., U.S.A., is now available with the scale beam graduated in kg. so that its use can now be extended to countries where the metric system of measurements is employed. The main beam of the scale is graduated from 0 to 75 kg., with divisions of 5 kg.; and the fractional beam is graduated from 0 to 5 kg., with divisions of 1/5 kg. The total capacity of the scale is 80 kg.

The beam is built into the scale and there are no loose weights. The scale is compact and can be used in any 18-in. square area. Bags of paper, cotton or burlap can be filled direct from bin or hopper with any free-flowing material, such as grain, seed, fertiliser or coffee and six to eight bags can be filled per minute.

Operation is on the suspension principle – bags must be clear of floor or other objects. A simple clamp, with a rubber-covered gripping bar, keeps bags of any material in position. The main hopper of the scale is of one-piece cast aluminium.

Operation of the Burrows bagging scale is on the suspension principle

Agricultural Chemicals

Fungicides; insecticides; killing slugs and snails; silage additive; control of reeds, rushes, weeds and brushwood

Corn and Grassland Weeds

'Blitzweed Super' is a selective weedkiller of the hormone type – MCPA – which has been specially formulated to give quick-acting control over a very wide range of weeds in corn and grassland and at a low application rate. This product is claimed to have considerable advantages over the use of 2,4-D, as it is more effective during unsettled weather conditions, since it adheres better.

The formulation does not contain solid particles or sediment and this ensures trouble-free spraying. It is also non-corrosive and does not deteriorate in storage. It is non-poisonous and has a wide safety margin should there be an accidental overdose in its application, and research has proved that MCPA does not depress crop yields.

It is stated that this special formulation, which is produced by the Vigzol Oil Co., will kill weeds at a low cost per acre and will increase profits by ensuring a better and cleaner crop.

*

Colloidal Copper

Copper preparations are very widely used in agriculture as fungicides, because they are cheap and they are long-lasting even in rainy weather. But the traditional copper preparations – the Bordeaux and Burgundy mixtures – have some disadvantages, since they need to be applied immediately after mixing, they are difficult to handle in the field, and they sometimes have an adverse effect on the growth processes of the plant, especially in the case of copper-sensitive crops.

Because of its special composition and formulation, 'Duphar' colloidal copper does not have these disadvantages, and the higher degree of effectiveness of the copper in this preparation is due to its very fine colloidal dispersion. As a result a smaller amount of copper needs to be applied to give the same coverage. Thus there is less danger of over-dosage, there is a considerable reduction or absence of adverse effects on the growth of the plant and there is less danger that the soil will develop an unbalanced nutritional condition in spite of repeated sprayings.

Potatoes, hops, celery and tomatoes; fruit trees, citrus and vines, as well as such tropical crops as bananas, coffee, tobacco and tea, are examples of economic crops which are sprayed with this preparation in order to protect them against fungus diseases.

*

Polyethylene Mulching

Greatly improved yields and earlier marketing of most crops, as well as economies in weeding and watering, can now be achieved by using black polyethylene film made from compounds supplied by Bakelite Ltd.

The film increases the soil temperature by between 5° and 10°, and this forces seeds to germinate more quickly and plants to grow more freely because of the increased nitrification and soil heat conservation. In addition, it reduces crusting and packing of the soil, thereby resulting in less seed rot and a much better stand under adverse weather conditions; it also effectively controls weed growth and reduces disease in the plants because it prevents them from being spattered by soil-laden water. The use of black polyethylene film also greatly reduces water loss and permits the use of furrow irrigation on porous soils. In general, only about one-third as much water is needed compared with rotary sprinkler irrigation.

Black polyethylene film is light in weight, flexible, and resistant to moisture and agricultural chemicals. It is used in widths of 3 ft. or so, and in a thickness of 150 gauge (0.0015 in.). In use the film is unrolled over the ground and the edges securely weighted down with soil. The film is pierced at the appropriate places, using a knife or sharp-pointed instrument, and plants are buried through the slit with a trowel. Alternatively, if plants are already rooted, the polyethylene film is laid over, slit above each plant, and this is then drawn through the film.

When irrigation is necessary the furrows are covered with the polyethylene film and 'T' shaped slits are made in the film, with the stem of the 'T' towards the direction from which the water is flowing. The steeper the slope, the closer should be the slits, varying from a separation of about 3 ft. on a 1-in-100 slope to 1½ ft. on a 1-in-10 slope.

Soluble fertiliser can easily be washed through the slits by irrigation water: complete fertiliser, which is put in ahead of the laying of the polyethylene film, is invariably utilised more efficiently under polyethylene film than in uncovered soil, because there is more soil moisture to make it available to the plants and, consequently, less leaching.

Many crops have been raised successfully using black polyethylene film for mulching. Under test, four times as much cabbage, three times the weight of cucumber, and twice the weight of potatoes were produced per acre. Yields of other crops, such as tomatoes and strawberries, were also substantially increased.

By using polyethylene film for row covering, crops can be protected against temperatures as low as —7°F. Consequently, growers can put plants outdoors very much earlier and market their crops several weeks in advance of the normal outdoor plantings. Where necessary, dead air space can be provided by stretching a further layer of film lightly over the first, which is allowed to sag slightly. This will protect tender plants, even against severe frosts.

*

Mercurial Spray for Scab

'Venturicide' is a wettable powder, containing 2½% of phenyl mercury chloride, which has been produced by Lunevale Products Ltd. to replace the use of sulphur. It can also be applied as an alternative to mercurated lead arsenate in cases where the use of lead arsenate is not required.

This spray, it is claimed, has been extremely successful in controlling apple and pear scab, and can be used with advantage on certain copper- and sulphur-shy varieties. It should not

be used later than six weeks before the fruit is picked. It can be applied with other washes, providing that they do not contain oil.

*

Seed Treatment

Out of the development work of the AAgrunol Chemische Fabriken of Holland has emerged a new compound with special properties, methyl-mercurypentachlorophenolate, or Me-Hg-PCP, otherwise known as '473'. This organo-mercury fungicide gives good control of many seed-borne fungus diseases, together with protection against wireworms and other hostile soil organisms. It specifically controls loose smut of wheat, *Ustilago avenae*, and it is claimed to be outstanding for the control of bunt of wheat, *Tilletia* spp.

This compound is only very slightly volatile, possesses no objectionable odour and has a low phyto-toxicity. Thus it is now possible to produce a combined fungicide-insecticide seed dressing which will make it possible to store treated seed for many weeks, especially if the insecticide chosen is dieldrin or aldrin.

*

For Silage

'Silotex' is an agricultural grade of sodium metabisulphate, which is used in the production of silage. It is a white, free-flowing powder, readily soluble in water, which is distributed throughout the crop being ensiled, as it is being placed in the silo. It is claimed that this Shell product ensures the production of good silage – even from difficult high-protein crops – by reducing the loss of protein and carbohydrates, preventing butyric fermentation and ensuring that a higher proportion of carotene (vitamin A) is retained.

*

Reed and Rush Control

'Dowpon' is a systemic herbicide which contains dalapon, which is the coined or common name for 2,2-dichloropropionic acid. It is used for controlling all annual grasses, such as meadow grass, blackgrass and wild oats; established perennial grasses, such as couch and water grass: phragmites and reedmace. It is recommended specifically for the control of grass in sugar-beet, in soft fruit and apple and pear orchards and in asparagus and potatoes.

The formulation, which contains 85% of the sodium salt of this acid, is most effective when it is used as a foliar spray, although it may be absorbed through the roots. When necessary, it may be applied with other herbicides, such as the ester formulations of 2,4-D and 2,4,5-T, so that broad-leafed weeds and woody plants can be controlled at the same time.

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A sodium metabisulphite silage clamp topped with a limestone seal. The method of feeding permits rationing of dairy cows with silage with minimum cartage

Malathion Formulations

Malathion is an insecticide of the organo-phosphorus group, which is not a deadly poison and can be used with safety providing it is handled with reasonable care; it has been officially accepted as safe for use in food storage and other commodity warehouses.

Malathion is the coined or common name for the chemical substance o,o-dimethyl dithiophosphate of diethyl mercapto-succinate. It has proved to be an effective insecticide against a considerable number of important pests of stored products, such as the grain weevil, the rice weevil, the saw-toothed grain beetle and the Khapra beetle, *Trogoderma granarium* – an extremely difficult pest to control.

'Malastan' formulations of this insecticide are recommended for spraying in warehouses, stores, grain bins, ships' holds, railway wagons and in conveying equipment. They can also be used to control a wide range of insects attacking ground crops, fruit trees, ornamental trees and flowers.

*

For Slugs and Snails

The Murphy Chemical Co. Ltd. offer three products for the control of slugs and snails. 'Slugit' pellets may be broadcast at ½ to 1 cwt. per acre or 'Slugit' dusting powder at about 56 lb. per acre; they are clean and easy to apply and are more persistent than the usual bran-type baits. Alternatively, the plants and soil may be sprayed or watered with 'Slugit' liquid slug-killer, using 1 pint of fluid in 20 gal. of water to treat 200 sq. yd.

*

For Killing Brushwood

Leek Chemicals Ltd. are producers of Wardle's 2,4,5-T and also 2,4,5-T esters – butyl ester, technical 78%, and a mixture of normal butyl and iso-butyl esters, 80%. They are used for brushwood killing, usually in association with 2,4-D esters.

*

A Compound Insecticide

After years of research Fisons have produced 'Kil', a compound insecticide, which does the job of a whole range of chemicals. It is harmless to all plants, except those of the narrow family, and is therefore safe to use. Its formula is on the secret list, but it is understood that its two principal ingredients are malathion and DDT.

World Crop Reports

Sugar — Yet another record

INTERNATIONAL REPORT

Sugar

All continents are reported to be increasing sugar production. In some areas this has been made possible by increasing the number of mills and refineries, and in others by increasing the efficiency of existing plants. World production of centrifugal sugar for 1957–58 is now estimated at 49.6 million short tons, raw value. This figure is 3.8 million tons or 8.3% above the 1956–57 production.

Non-centrifugal sugar production for 1957–58 is now estimated at 7.5 million short tons. This total is 1.6% more than for the 1956–57 year, when Colombia's production was unusually low, but is 2.5% less than the record produced in 1954–55.

The increase over 1956–57 in world production of centrifugal sugar was relatively greater than the increase in world population and production per person increased by about 2.4 lb. The new level of production is nearly 38 lb. per person per annum. This will result in a further rise in *per capita* consumption of sugar, or an accumulation of sugar stocks, or both.

As in other recent years, cane sugar makes up more than half of the world total centrifugal sugar production. Centrifugal cane sugar output for 1957–58 is now forecast at 29.1 million short tons, raw value. This quantity is 59% of the world total for beet and cane sugar combined. It is also larger than centrifugal cane sugar production in 1956–57 by 1.5 million tons or 5.4%.

World beet sugar production during 1957–58 is now estimated at 20.5 million short tons, raw value. This is 2.3 million tons, or nearly 13%, more than the 1956–57 output. The increase is due largely to more favourable growing conditions in Europe than existed during the 1956–57 season. Growing conditions for sugar-beet in Europe were very poor during the 1956–57 season, especially in France, Germany, Poland and Czechoslovakia. Europe produced 11 million tons, raw value, beet sugar in 1955–56, only 10.2 million in 1956–57 and 11.7 million tons in 1957–58.

Most *European* countries produced more sugar during the 1957–58 season than a year earlier and the total of 11.7 million tons for 1957–58 is the largest on record. This record is the result of favourable growing conditions and more efficient methods of handling the crop. All countries of Western Europe, with the exception of Italy, Spain and the U.K., produced more sugar during 1957–58 than during 1956–57. France and West Germany are the largest producing countries. France produced slightly less than in 1955, but 214,000 tons or nearly 14% more than in 1956. West Germany produced a record large output, 470,000 tons more than in 1956. The U.K. experienced a mild winter and dry spring, resulting in an epidemic of virus yellow, which caused a low sugar content. Italy's low sugar production resulted from excessive rain, which more than offset a 2% increase in harvested acreage. Spain has been plagued by dry weather.

In Eastern Europe, Yugoslavian sugar production is now unofficially estimated at 260,000 short tons, raw value. This is an increase of 30,000 tons over the estimate of last autumn. All but one Eastern European country increased production of sugar in 1957–58 over the previous year. In Hungary, production remained the same as last year. The total Eastern European production shows an increase of 30% over last year. Considerable uncertainty still exists as to the quantity of sugar to be made from the large quantity of sugar-beets held over in the U.S.S.R. for processing in early 1958. However, U.S.S.R. sugar production is now estimated at 5.5 million short tons, raw value. This is an increase of 700,000 tons above the autumn estimate of 4.8 million tons. From this beet crop 5.5 million tons of sugar is anticipated.

Production of sugar in the *North American* area is increasing, as it is in all other large areas of the world. The total of 15.1 million tons is a 3.9% increase over 1956–57 production. Cuba, the largest centrifugal sugar producer in the world, has restricted the 1957–58 crop to 6¼ million tons. The prior year's production was larger by only 2,000 tons. Increased burnings of sugar-cane by rebels is causing some damage, but is not expected to reduce the crop below the restricted level.

Production in *South America* is estimated at 5.7 million tons, an increase of 484,000 tons above the 1956–57 crop. Brazil, the largest producer in that continent, is expected to produce 3.1 million tons. This is an increase of 477,000 tons or 18% over the 1956–57 crop. Sugar production and consumption have increased proportionately during the recent years, except for the 1955–56 crop, when production was slightly less than the 1954–55 crop. Peru is now expected to produce 796,000 tons in 1957–58. The drought and shortage of irrigation water which so greatly reduced the 1956–57 crop have continued into late 1957 and early 1958. Argentina's crop for 1957–58 was only 770,000 tons, while the 1956–57 crop was 850,000 tons. The decrease was the result of frost and floods during the growing season. The only other South American country whose production is expected to be smaller than the previous year is Venezuela.

The preliminary figure for 1957–58 production in *Africa* is now placed at 2,627,000 tons, an increase of 6% over the 1956–57 figure of 2,478,000 tons. The Union of South Africa's production increase of 100,000 tons over 1956–57 largely accounts for the increase. The weather in South Africa in 1957 was very favourable for growing cane and the autumn weather conducive to high sucrose content.

Total production in *Asia* is now shown to be somewhat higher in each year than as previously published, due mainly to a revision of estimates for mainland China. These revisions are based on recently reported official figures. The 1957-58 sugar output of Asia is now placed at 7.4 million tons, compared to 6.9 million in 1956–57. India's production is now estimated at 2.7 million tons, compared to 2.5 million tons in 1956–57. India continues to build new mills. During the past two years, India has licensed 55 new factories and the expansion of 68

existing factories. According to plans, this expansion and construction programme, when completed, will increase centrifugal output by 1.2 million short tons. Sugar production in Formosa is expected to reach this year a total of 900,000 million tons against the 1958 initial export quota of 750,000 million tons fixed by the International Sugar Council.

Oceania has also increased its production due to expansion of the output of existing mills and refineries. Australia increased cane acreage per farm and cane yield per acre.

REGIONAL REPORTS

India

India's 1957–58 *groundnut* harvest amounted to 4,783,520 short tons from 14,457,000 acres, according to the final official estimate. Partially revised final figures for 1956–57 are 4,704,000 tons and 13,450,000 acres.

Tunisia

Prospects are reported to be very good for the *wheat* and *barley* harvest. Unusually heavy rainfall this season has been a favourable factor in most regions, though in parts – especially in northern Tunisia – conditions are uneven because of too much rain.

Most of the country's soft (bread) wheat is grown in the north. A good part of the durum and some barley are also grown there. European farmers predominate in the area and many of the farms are highly mechanised. In central and southern Tunisia conditions are very favourable and a bumper crop seems assured. Above-average grain crops were also reported for Tunisia in 1957.

Formosa

The 1957 *rice* crops yielded a total of 1,832,698 million tons, 1% short of the target figure, but 42,769 million tons higher than in 1956. The target for 1958 is set at 1,950,000 million tons. The acreage under cultivation was less than had been planned owing to lack of rainfall in central and southern Formosa in April last year. In spite of this, the harvests were good, weather conditions taking a turn for the better later in the year.

Tea growers had a rather discouraging year at a time when Formosa faces increased production and competition in the world market. In some cases the price of Formosan tea was forced below cost, with the result that production has been cut back by as much as a quarter.

Pineapple exports dropped in value during 1957 by some U.S. $1,500,000, largely owing to difficulties at the canneries.

Yugoslavia

The published figures for crop yields in 1957 have borne out and in some cases exceeded the optimistic harvest estimates made earlier in the season. In general, agricultural production is stated to have been 35% higher than in 1956. The following are the official estimates for the principal crops compared with the corresponding figures in 1956. The figures for maize, fruit and industrial crops are provisional:

	Crop yields (in thousands of metric tons)	
Grain crops	1956	1957
Wheat	1,600	3,100
Rye	205	280
Barley	344	604
Oats	324	484
Maize	3,370	5,560
Industrial crops		
Sugar-beet ..	1,130	2,020
Hemp (unretted)	220	912
Sunflower seed..	59	89
Tobacco ..	31	56
Fruit and vegetables		
Plums	180	592
Apples	95	105
Potatoes ..	2,190	3,220
Grapes	656	911

1956 was admittedly a poor year for cereal crops, but at 3,380,000 tons the 1957 yield of bread grains (wheat and rye) was 1,100,000 tons above the 1947–56 average. The area under wheat in 1957 was estimated at 1,970,000 ha., compared with 1,620,000 the previous year, and the average yield 15.8 metric quintals (of 100 kg.) per ha., compared with 9.9 in 1956. The average yield on private holdings is given as 15.2 quintals, on co-operatives 22.1, and on state farms 24. The average maize yield per ha. in 1957 for the whole of the country was 21.5 quintals. But the figure varies greatly for different parts of Yugoslavia. The average post-war yield (1947–56) for the whole country was 14.2, compared with 16.4 quintals pre-war (1930–39).

The estimated area sown to wheat in the autumn of 1957 is 8% more than in 1956. Additional imports of hybrid maize seed have been procured to increase the area sown this year with higher-yielding varieties.

England and Wales

The weather at the beginning of April was mainly cold and dry. Scattered snow showers occurred in eastern districts, and the end of the first week brought very cold weather with widespread rain and snow. After a period of light showers of rain and snow, the weather from mid-month was mainly cloudy and milder with a little rain.

On the whole, conditions during the month were very favourable for the sowing of spring corn and good progress was made. Good seedbeds were obtained except on some late-ploughed heavy soils.

Autumn-sown *wheat* was generally satisfactory and had recovered from the effects of the cold weather. Spring-sown wheat had germinated fairly well on the whole, but growth was slow. The small areas of autumn-sown *barley and oats* looked promising. Spring-sown barley and oats had germinated slowly and where 'through' appeared satisfactory. *Rye and mixed corn* were generally satisfactory.

Winter *beans* for stock feeding withstood the cold weather well. Spring beans were just coming through and germination appeared satisfactory. *Peas* for stock feeding had germinated slowly and growth was retarded; some bird and weevil damage was reported.

Conditions were favourable for planting *potatoes* during the month and, except on some heavier soils, good progress was made in most districts. Early crops were making slow growth.

Conditions were favourable for the preparation of the land for root crops and good seedbeds were obtained. The sowing of *sugar-beet* was well advanced, but the sowing of other crops was less forward. Progress was made with the drilling of *mangolds* in some areas. A few early sowings of *kale* were made and the preparation of seedbeds was well forward.

Leys were growing better towards the end of the month, but were still backward. *Permanent pastures* were still bare in many areas, but were improving. Less grazing than usual was provided.

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